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ABSTRACT

An Institute for State and University Level Adult Basic Education Personnel was held to provide insight into the philosophy, potentials, problems, and techniques of programmed and computer assisted instruction as they relate to adult basic education programs. Speeches given at the institute are reproduced in this publication. The titles and authors of the speeches are: "Psychological Foundations of Individualizing Instruction" by Lawrence Stolurow; "The Systems Approach to Educational Programs" by Lawrence Stolurow; "Programming Success for the Undereducated Adult" by Mark Laurence Berman; "Computer Time Sharing in an Adult Basic Education Project" by Sue Stephenson; "Educational Project Management Techniques" by Desmond L. Cook; "Course Authoring Techniques for CAI" by Peter Dean; "Multi-Media Design and Media Selection" by Donald T. Tosti; "Computer Assisted Instruction: An Overview" by Walter Dick; "Evaluating Programmed Instructional Materials" by Ronald H. Sherron; "Integrating Programmed Instructional Materials into ABE Programs: The Learning Laboratory Approach" by Joseph B. Carter; "Systematic Use of Programmed Instruction in Basic Education" by Grady M. Meredith; "Developing Programmed Instruction (P.I.) Systems and Materials" by Virginia Zachert; and "Multimedia Programming" by Shirley B. Bitterlich. (DB)

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PROGRAMMED INSTRUCTION AND COMPUTER ASSISTED INSTRUCTION IN ADULT BASIC EDUCATION

AN INSTITUTE FOR STATE AND UNIVERSITY
LEVEL ADULT BASIC EDUCATION PERSONNEL
JULY 21-AUGUST 1, 1969

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EDITED BY

DR. MARY LOUISE COLLINGS

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ADULT LEARNING CENTER

School of Education, North Carolina State University, Raleigh, North Carolina
Dr. Carl J. Dolce, Dean

ADULT LEARNING CENTER

The Adult Learning Center was approved and established as an experimental and demonstration project in adult basic education in 1967 under the provisions of Section 309(b) of the Adult Education Act of 1966. The Center is an integral part of the research and development program of the School of Education at North Carolina State University. The purpose of the project is the identification, development, and evaluative of innovative curriculum materials and instructional methods that will accelerate and enhance learning in undereducated adults. Special emphasis has been placed upon investigations into the utilization of modern educational technology for the instruction of undereducated adults. A major concern of the Center is the development of packaged instructional materials and improved instructional methods which are capable of being institutionalized within adult basic education programs in public school systems. The Center is totally committed to the belief that its research and developmental efforts must give promise of materially improving the ongoing adult basic education program at all levels, local, state, and national.

The Center is part of the program conducted under the Auspices of the Bureau of Adult, Vocational, and Technical Education, Division of Adult Education Programs, Office of Education, U. S. Department of Health, Education, and Welfare. The program of the Center cuts across the Schools of Education, Agriculture and Life Sciences, Liberal Arts, and Physical Sciences and Applied Mathematics at North Carolina State University at Raleigh.

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The Seminar and Conference Program of the Center has been established to facilitate the coordination of the programs of the Center with other agencies and individuals interested in research, development, and evaluation in adult education. Position papers and other scholarly manuscripts in the Seminar and Conference Reports are intended to provide the underlying framework or rationale for the initiation of experimental and demonstration projects either under the program of the Center, as projects to be initiated by a consortium of institutions interested in cooperatively engaging in broad frontal attacks on problems of major, far-reaching significance, or by researchers throughout the nation. The Center Seminar and Conference Report series is the vehicle adopted by the Center for publishing these manuscripts as interim reports of the Center.

ADDITIONAL INFORMATION

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PROGRAMMED INSTRUCTION AND COMPUTER ASSISTED INSTRUCTION IN ADULT BASIC EDUCATION: AN INSTITUTE FOR STATE AND UNIVERSITY LEVEL ADULT BASIC EDUCATION PERSONNEL

DR. MARY LOUISE COLLINGS, EDITOR

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The institute reported herein was conducted pursuant to a grant from the Office of Education, U. S. Department of Health, Education, and Welfare. Grantees undertaking such projects under government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions do not, therefore, necessarily represent Office of Education position or policy and no official endorsement by that office should be inferred.

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ADULT LEARNING CENTER
NORTH CAROLINA STATE UNIVERSITY AT RALEIGH
RALEIGH, NORTH CAROLINA
MARCH, 1971

FOREWORD

The Institute reported in this volume brought together some of the most outstanding national leaders in the field of educational technology. Its participants were drawn from state and university level adult basic education personnel from among the fifty states.

The purpose of the Institute was to give participants insight into the philosophy, potentials, problems and techniques of programmed instruction and computer assisted instruction as they relate to adult basic education programs.

The use of individualized instructional techniques currently offers a promising means to increase the efficiency of learning among the undereducated adult population. When appropriately designed, programmed instruction insures that the learner actively responds to information and is promptly provided feedback and remedial instruction within seconds after his demonstrated need for them. Computer assisted instruction affords the learner experiences through a multi-media approach.

While recognizing the values to be gained in utilizing educational technology, few adult basic education personnel understand how to use its techniques. During the Institute, each participant had an opportunity to inspect and use a variety of PI and CAI materials in order to familiarize themselves with the techniques against the background of appropriate selection criteria. The informality of instruction allowed for full discussions between participants and instructors.

The major speeches presented at the Institute were taped and transcribed for publication. We are grateful to each speaker who edited the transcribed material and gave permission for its reproduction in this present volume. It is hoped that the presentations reproduced here will convey to the reader some of the enthusiasm and rapport with the speakers which participants in the Institute gained from live presentations.

The proceedings of this Institute will extend to a larger audience some of the benefits that accrued to those present at the Institute itself.

Edgar J. Boone
Head, Department of Adult and
Community College Education
North Carolina State University

Raleigh, N. C.
March, 1971

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PSYCHOLOGICAL FOUNDATIONS OF INDIVIDUALIZING INSTRUCTION

Lawrence Stolurow, Director
CAI Projects, Harvard Computing Center

I want to try to give you at least one point of view with respect to what might be called a reorientation to learning and instruction. An orientation which I think is gradually becoming the point of view that many people are adopting and trying to put into effect.

The need for change within educational systems, particularly schools, is something which has been stressed for a number of years. I think Marshall McLuhan made the statement that schools and railroad people were the two societal institutions that have not been changed over the years. While education is the social mechanism by means of which we pass information on and presumably consolidate it into more effective form so that individuals are able to cope with the future, it seems to me that yesterday's and today's events indicate the tempo that is with us and suggest the need for our educational institutions to make some rather drastic changes.

A number of commissioners of education have mentioned at one time or another the notion of individualizing education. If we are to pick a single theme or topic the notion of individualization is one of the main concepts that is being worked with in order to make this change which everybody feels should be coming about. There are a variety of bases for change. They come not only from the youngsters who are asking for more relevant education but also from adults. As you well know, there is a variety of kinds of adults.

I don't think there is any adult in our society today who can afford not to be concerned about education, about his education, simply because things are changing so rapidly that he soon becomes out-of-date unless he does make some effort to re-orient his thinking and to develop new skills.

First I would like to mention some facts which I think identify some needs with respect to education. It has been estimated, for example, that 50 percent of the labor force today earn their living in industries that did not exist when the country began. A third of the items on the super market shelf did not exist 10 years ago. One half of what we learn in school is no longer valid when we reach middle age. Ninety percent of the drugs prescribed today were not even known 10 years ago. More mathematics, chemistry, and biology have been created since 1900 than in the entire prior period of recorded history. One half of what a graduate engineer studies today will be obsolete in 10 years. These kinds of statistics indicate that we must provide not only for the education of the group to whom we relate, but we need to build into the institutions that provide that education, the means by which they can keep pace with the changing times. Change is obviously greatly accelerated, and I feel it is likely to continue to accelerate.

The question then is, if we are going to try to respond to these needs, and if we are to take the theme of individualizing education, generally how do we go about doing it? I would like to start by first summarizing, very briefly, some concepts from the

psychology of learning which are basic to an analysis of an interaction that takes place between a student and some source of information-teacher, book, or some other medium. Fundamentally, the psychologist assumes that man has evolved as a biological organism in a way which distinguishes him, in terms of his cognitive or rational abilities, from other animals, and these processes have reached a state which engineering has identified as self-organizing. This means that with higher levels of intellectual abilities the individual is capable of not only responding to his environment, but also of accumulating this experience and organizing it in ways that make him more adaptive. The "survival of the fittest" notion was fundamental to much of our recent thinking and, unfortunately, much of our current thinking.

However, with programmed instruction and more recently computer-aided instruction, a new set of concepts has been identified which derived fundamentally from some thinking provided us by Norbest Wenier, who was concerned with the human usage of human beings and the relationship of man to the physical environment which he himself has created in terms of the machine. Prior to the computer era, man created tools which helped him work, helped him get more labor accomplished, helped him move larger masses, move them more rapidly and with greater force. The computer on the other hand is an intellectual or conceptional aid to man. It helps him in rational problem solving. It permits him to analyze complex problems to cope with problems in short periods of time which previously would have taken many man-years.

In order to utilize this kind of technology effectively, it is necessary that man relate in some effective manner to these adaptive mechanisms. Now we can think not only of man adapting to his environment, but of his generating machines that adapt to his needs. We can think in terms of instruction, of the new machines being adaptive machines in the sense that they can be designed to adapt to the individual and to provide him with the optimum organization of information and practice which is required in order for him to perform more efficiently. This notion of the environment adapting to man as opposed to man adapting to the environment is extremely important thinking, and fundamental to a real appreciation of computer-assisted instruction. Adjusting to this kind of environment is something with which all of us will sooner or later be faced.

Psychology itself, as a profession, has given primary emphasis upon its theories of learning under conditions in which man is adjusting to a rather fixed, or at least specified, environment that maintains certain critical characteristics. Teaching in the classroom generally has followed this pattern where the teacher defines the environment for the student and those who manage to cope with that environment most effectively are considered to be the best students. Those who do not, are those who are dropped by the wayside.

The emphasis today on the individual is coming about when we are developing our technology to a higher level. Consequently there is much confusion in thinking with respect to the relationship of man to

technology. The question is, is man the master of the technology, or vice versa? Related to this question is the concern which many have that the inclusion of equipment, sometimes referred to as hardware, into the classroom or in the interaction with students is a deep impersonalization of the instructional process.

I hope that after we have concluded this series of meetings, and your visits to the CAI Laboratory, you will leave with at least a question with respect to the validity of that idea and hopefully you will be convinced that modern hardware, in the form of the computer, is an adaptive device that produces a greater humanizing environment, a more individualized environment, than we have been able to accomplish in the past with individual media and unrelated visual aids. These have been more often a burden to the teacher than a help.

Now the question is what kind of thinking is important in trying to cope with this situation? We have seen the advances made to land on the moon. I feel that some of the changes we are seeing on the horizon in education are going to have an equally important impact upon our whole way of thinking regarding the way in which we relate to one another in an instructional situation. I mentioned earlier that psychology had sort of laid a foundation of individualized instruction in the sense of one-to-one relationships with individuals in the learning environment but had defined those situations primarily in the role of Darwin - of the survival of the fittest - namely, with a fixed environment and an individual who adapts to it. In that

context, however, a number of very useful results and a number of very useful theories have emerged. While the model has changed somewhat, because of the conditions that are now possible, it is nevertheless true that some insights have been provided by psychological research on learning theory.

The Purpose of Research

But before talking about some of that research, I want to emphasize clearly the fact that research on learning is not co-extensive with, and equivalent to, the research on instruction. Learning and instruction are quite separate processes. They are sometimes confused and in many cases the psychology of learning is taught to teachers with the assumption that this is all they need to know in order to become good teachers. When we reflect upon it, teaching is an active process encompassing more than just learning. The psychology of learning is the result of teaching and the question which the teacher or the teacning system is confronted with is the question of how to structure the environment in which the individual works in order for him to modify his thinking and/or actions in ways which permit him to achieve certain instructional or educational goals.

Learning Psychology

We generally assume that the environment in which the individual finds himself becomes represented internally in some symbolic manner. The stimuli which exist in his environment are somehow represented in the nervous system, as are his own responses. The problems of psychology that are most frequently thought of with respect to learning

are ones in which there is an appropriate relationship established between these representations of stimulation and the representations of response. The internal process which relates stimulus representations and response representations is frequently referred to as a mediating process. It mediates between the external events of observation and of overt behavior. To refer to this, psychologist coin various symbols to represent what goes on under the skin presumably in the central nervous system.

Obviously in instruction and in learning one is concerned not only with cognitive processes. In fact, in the general taxonomy of learning behaviors there are three groups of behaviors that relate to the terms that I just used; namely, the cognitive domain, the psychomotor domain, and the affective domain. And when we identify objectives for instruction, when we determine what it is that we are ultimately seeking with respect to the instruction which we provide students in a selected learning environment, it is with respect to those three domains that we have reference.

We need to distinguish also between the associative process and prior level or more abstract processes upon which the very fundamental ones build. There are other notions of thinking, reasoning and problem solving which have varying degrees of acceptance and currency and definition but fundamentally the search of the psychologist is one which attempts to make inferences about these processes which none of us can see in any one else and frequently are unaware of within ourselves.

But the problem here is to build theories based upon information which is reliable and which permits us to infer what's going on within an organism. To understand, in other words, what the psychologist is trying to do is fundamental to the realization that he is trying to proceed in a particular manner to arrive at a state of understanding about processes and to test that understanding by means of prediction. The idea is, one's theory is only as good as the predictions based upon this theory. To the extent that the model for the theory he uses allows him to make extrapolations into the future, then he feels that that theory is effective. Two theories are frequently decided upon in favor of one or the other, depending almost entirely on the ability of each to account for existing data and to predict future events.

So this is what learning theory is about, it is concerned with the internalization process and the representation of it. The manipulation with conditions in the laboratory is more often an effort to understand the mechanisms that are assumed to exist within the individual than it is to achieve a particular learning event or performance of any social value.

However, there is a growing trend which I think is highly desirable, that is, an attempt to create within the real situation the necessary conditions of learning, or study under those constraints and limitations which permit the learning psychologist to infer something about the process that is involved in the performance that he and others have observed. The idea is to attempt to create

laboratory-like conditions within real environment. Now the word "laboratory" is considered by many to be inappropriate, or something undesirable. Really all that it means is a set of conditions which permit an investigator to make some inferences that something is related to something else.

The whole process of statistical analysis of data, the logic of research design, is the set of conditions which will permit inferences once observations are made. If one cannot draw an inference and relate something that happens in the future to something existing prior to that time, then one has not moved ahead with respect to theory or science and one has no more knowledge about what to do next time.

Learning theory is the search to achieve ultimately a state of understanding which can provide guidance with respect to the design of instructional material, guidance with respect to teacher training, guidance with respect to how to teach students to learn to study or to work so they can learn more efficiently or more effectively. When I mention "mediators", I am speaking of inferential processes for which there are existing experimental designs and conditions that permit an individual to make an inference that something appears to be taking place within an individual and that it has certain properties. We speak sometimes of representational mediators. These are mediators, processed within the individual, that represent his environment. We have stimulus mediators so we can speak of internalized cues of images, we have process

mediators which refer to the internalization of responses which represent action or behavior or performance in some internal way.

Responses

The psychologist's use of the term "behavior" may seem strange to you. I am not talking about behavior in the sense of the child's good behavior or bad behavior, but any performance of the individual, any observable kind of action. When the psychologist refers to behavior, he means anything observable about a third party which represents his performance.

Intentions, or goals, or motivations are critical events with respect to the individual's direction of behavior, with respect to the selections that are made in choosing among alternatives within an environment. Generally it is assumed that stimuli when represented internally are not represented in total. There is some fragmentary representation and this is frequently cumulative representation so that with increasing experience a greater or more comprehensive representation of external events becomes internalized.

Many of us also assume that the responses we make to a situation have a complex set of characteristics. Our attention is usually focused on the most obvious characteristic of the response; on the other hand, when a child is responding to an object that he can consume, there are not only the chewing and biting responses but also the salivary response. These I distinguish only to illustrate the fact that some part of the total response to

stimulation is frequently capable of appearing independently of the event that initiated it. The response is thus a set of responses rather than a single responce. Some parts of it are capable of independent activity or appearance and can anticipate the larger response of which they were originally a part.

In addition it is frequently assumed that responses produce stimulation. All of you are quite aware that you can close your eyes and lift your hand and tell the position of it. You can do that because you have sensory feedback from your muscles which tell you something about the position. Coupled with responses are cues, or sensory information, which give you some useful information bases, coupling that response with some other response. So responses should be thought of as cue-producing, as being capable of providing you with stimulation which in itself can be the c : for additional responses. It is in this way that we learn serial behavior, or complex motor acts, such as dancing or playing golf. The responses become cohesive sets because one becomes chained to the other.

These are some fundamental notions that represent some of the current thinking with respect to psychology of learning that give us somewhat of a foundation for considering certain problems in teaching and instruction.

Transfer of Training

Another field of important contribution is the area of transfer training. Historical roots go back to about 1900 in this area.

It is concerned with the question of how someone learns one thing and its influence on the learning of something else. There are three kinds of results. Either the first task can facilitate the learning of the second, it can be neutral with respect to the learning of the second, or it can inhibit it. Transfer of training provides us with some conceptions that help us in understanding the larger learning unit that takes place in school and obviously it is our purpose in instruction and particularly in curricular development to maximize positive transfer, to introduce sequences of experiences which build one upon the other in facilitating ways as much as is possible. The understanding of how this is done is a critical understanding from the point of view of the larger unit of learning and the larger units of teaching. Hence, when we talk about instruction, we are really more concerned with transfer concepts than we are with the concepts of learning themselves. The concepts of learning that I have outlined for you are concepts which provide the foundation for learning which, in turn, becomes the basis for transfer. There are many concepts of transfer training and this is an entire area of research and development.

Individualized Instruction

Since we couldn't possibly do justice to such a broad area in today's presentation, I have chosen to present some of the thinking about the new systems of instruction, particularly, computer-based systems of instruction. I would like to share

with you some of the thinking that has been important in guiding our work, which tends to put both programmed instruction and computer-aided instruction into a more systematic framework.

This analysis, which I have labled "the ideographic model", highlights the fact that we are focusing our attention on the one-to-one relationship of the student to some instructional environment. We are not dealing with group environment, as such, but we are focusing on the individual. Group interactions are not excluded, however, and I will mention this later.

In considering the process, I have made a distinction among three sets of decisions. One set of decisions is those decisions which take place before instruction is actually initiated. Now it seems to me if we are serious about individualizing instruction, then we need to begin with the individual and some of his characteristics. A set of these characteristics has been identified in terms of conventional ways of representing them; the aptitude of the student (and this would be relevant aptitude for the material that is being taught); his knowledge or achievement level prior to the entry or beginning of the instructional experience; and something about the personality characteristics of the learner which help us in relating various characteristics of the environment to his needs and expectations. These then are characteristics of the student. A second set of decisions are based on information of importance about the instruction, its objectives, the topics to be covered, the final level of performance

on those topics and the amount of time that we can maximally allow for his accomplishment of these objectives.

Given these two kinds of information, the problem which we have as a live teacher, tutor, guidance counselor, or computer-based instructional system is the search for a teaching program. By program we mean two things, first of all we mean some content that has been defined, usually subject matter, and second, some method of instruction which I will call a strategy of instruction. We can differentiate an inductive from a deductive strategy. In other words we can go from specific examples to general principles or vice versa. For example, the same subject matter by providing the individual with examples of words spelled according to a rule, or we could present him with the rule and then give him illustrative words to spell. Now one of them, the former, was an inductive rule or strategy of instruction; the latter was a deductive rule or procedure of strategy of instruction. The idea is that a program consists of content, a specified set of works, the example of spelling and the rules that are to be taught and, secondly, the order or sequence or manner in which this material is presented. We call this a set of conditions and given that, we have specified a variety of programs and, based upon experience, we can make certain basic sets of predictions.

(1) We can select more than one program which will achieve our objective with each student we're working with; then we evaluate the instruction we provide according to some efficiency

criteria, such as which will do it in the minimum time, or which one will take the least effort, or which one makes best use of our existing resources.

(2) A second alternative is to locate a single program, and only one; having done this, we then teach.

(3) The third alternative is one which all too frequently comes up. The idea is clearly expressed in advance, but the problem here is that we cannot find an appropriate match between these individuals and the objectives, a means by which a program would relate the two. Consequently we have to make some new decisions. We can increase the student's information level and this can be done by giving him some separate instruction through a variety of means. Another way is to change our risks and gamble a little more and accept some students who have a high enough aptitude level that suggests that possibly, through the course of instruction, they could compensate by some additional effort and increase the probability that some of them will survive. but, obviously, the risk is greater than with those who met the conditions above.

(4) The other possibility is to change the actual objectives, or the time that is allowed or the final performance level that one would find minimally acceptable for the students.

Given a change in any of these new decisions, the information has to be re-processed in order to determine whether or not teaching will take place. These processes, I think, are real ones. They are not often formalized, but they need to be if a proper

system is to be designed that copes with the initial decision-making for individualizing instruction. Exactly how they are handled varies tremendously, depending on the particular program, the group that is participating and the resources available to us. Nevertheless, this set of processes has to be developed if we are going to begin a truly individualization of instruction.

Now we come to the second set of decisions that has to be made when we are individualizing instruction. And again these are not unique to a computer; they are not peculiar to PI or CAI. In my view, they represent fundamental processes which every teacher has to go through if he or she does a complete job in the individualization of the instruction that is being provided.

We can introduce the notion of cybernetic process here. The word "cybernetics" comes from Norbest Weiner who did some very early work in the mathetics or modern computers. We have the student or learner who has to respond to something in his environment. Now the question is, what happens when he responds.

When the learner makes a response some standard is immediately taken into account upon which a decision is made that that response was correct or not - was appropriate or not, was acceptable or not. Now in modern technology, programmed instruction and CAI, we make our performance standards implicit right from the start. We say that the student has to make this, that, or the other response before we will call it correct, and

we will call these responses, these partially correct, and these incorrect and interpret the answers in these categories. This is the whole business of making it quite clear in advance what will be used in making a decision about the adequacy of the student's performance. Now the fact that you have these standards is not enough. One has to compare the standards with the response. The actual process of comparison is a separate process, and this becomes very apparent when one is writing computer-aided instruction material, or when one is developing programmed instruction material and has to allow the student either to make the comparison or have the machine make the comparison. It is a distinctive process sometimes fallible, or somewhat fallible, depending on how it is accomplished.

When a comparison has been made, whether it is correct or incorrect, these things usually happen. First, some knowledge of results is provided the learner. He is given some information as to the correctness or incorrectness of that performance.

This information is conveyed in a variety of ways, the simplest of which is that something else happens, the scene changes in some distinguishable way. In other cases, the student is told that he is right or wrong. Many programs of instruction show as the first word in the next frame "Right" or "Wrong" to make it quite clear to the student that he has in fact made a correct or incorrect response.

Another thing that happens is that a rule is invoked that provides a selection with respect to what happens next. The simplest, least interesting, selection when you have made a linear program and every student has made a response to frame one, is that the booklet selects frame two for him. "Branching", for example, and "contingency management", are terms used to represent the fact that there are existing systems which will make a selection for the student based upon the response previously made, so selection can become quite an elaborate process. It is either intuitive or predetermined. There are no options or a large number of options are set up and one of these occurs on some basis. In addition, some record is made and usually collected so that we know what response or performance went with what experience. That is ideal. But one could simply record this; teachers do it all the time and they make statements to the effect that "Oh, that's Bill and Bill always needs to be presented something three times before he pays attention to it", or something of the sort. The idea is that the collated record three times, or whatever is the recorded information, accurate or inaccurate, complete or incomplete, selective or non-selective, is available in the system for use and it may be utilized for making selections or it may not. It may simply be used in making decisions about grades and other uses of this sort.

In addition, there is usually a pacer, or timer control, some means by which the system presents material faster or more

slowly to students. There is some control over the speed with which the interactions take place and the speed can be in the display, how long it is shown, how quickly it is shown after response, or it can be in terms of how long the student has to make his response. There are a variety of controls of time, all of which can alter the way in which the student performs the learning task.

I prefer to describe the instructional resources, however they are formed, as a library, and to think of the system as including a teacher. This would mean the selection of material from information already available plus items in her head, let's say, but it may also be a computer in which data are in the memory, and on slides or tapes, and stored in a variety of ways. The selection process picks out items from such a storage unit of some kind, which we call a library, and puts them in a form which is then presented as a display to the learner. The fact that it puts them in some form combined with identification of some content that was presented according to some organizational rule, gives you the program step and ultimately the display. Now I think those are fairly fundamental sets of conditions which give you a general framework with which to look at any interaction between the student and a teaching system or teacher, whichever happens to be active at the moment. The idea is, then, to try to think of interaction according to the set of classifications in order to sort out the functions which

the different steps really perform. You want to keep in mind that we are functionally oriented. Just what function does each action serve when we are interacting with students? What is being accomlished by the event that is taking place - an event initiated either by a student or a teacher?

Now I want to mention the third step but I won't go into it so completely. I like to think of this step as considering resource management decisions. I think that considering them as resource management, rather than computer-managed instructions, is a more useful concept. You hear more talk currently about CMI, that is computer-managed instructions as opposed to CAI, as if they are in opposition. My feeling is that if you take seriously the idea of a systems orientation to the instructional process, then putting CMI in competition with CAI is an artificial distinction.

One cannot take a systems approach and ignore either one; the idea being that, when you identify a set of contents and a set of rules for teaching a particular student, teaching interaction is taking place according to that program. While that is taking place, the computer is monitoring that in keeping records and keeping an accounting system, so to speak, as to what is happening with respect to the performance of the student, with relation to expectations, [and] if the student's performance comes up to expectations that teaching interaction continues according to that program. On the other hand, if the instruction is not producing the results that are expected at various check points,

it is possible to change the program. We do this frequently, for example, when we call in a remedial teacher in elementary school; that is, we call in a specialist to assist us in teaching a student when we are not able to relate effectively to him. Systems also can do this by having an alternative available so that, when the first program selected by the preinstructional process is found not to work, the alternate program can be substituted. That is all that is meant by [this duality here and] building CAI systems with alternatives. Alternating or shifting from one program to another is only now coming into actual use; however, we need to study its use much more intensively. Superimposed on that kind of management or monitoring is the usual administrative monitoring which takes care of a variety of activities such as the utilization of the other audio and visual resources, the scheduling of teachers, determining when they will be available so that when students complete certain objectives by one means they are grouped or sent to a teacher or another computer for further instruction. By the management of resources we mean the ability of the system to keep tract of developments with respect to student progress and to identify the possible resources that can be utilized with the student who has achieved a certain level of performance.

Now we have been talking about individualizing instruction. When we get to this type of problem of resource management it becomes appropriate, I think to be sure that when we are using the term individualization in this context we are all thinking of

the same thing. By individualization in this context, I mean "prescription". I do not mean learning in isolation. Many people translate "individualization" to mean "learning in isolation". It would be quite appropriate at any point in time for "prescription" to contain a suggestion, or recommendation, that the individual work with several other individuals at that time to discuss, to analyze as a group, to debate, a particular issue or point which has been taught to that individual by some more isolated means. In other words, "prescription" is the better synomyn for "individualization" than "isolation". The idea here is to prescribe the particular set of learning conditions, whether it is an interaction with other students or whether it is a debate or classroom participation and discussion is not critical. The critical thing is that the appropriate kind of interaction be identified and that arrangements be made so that it can be accomplished. It is this aspect of instruction which we mean by individualization. It means that the system is relating to the individual needs; it is not that he is learning in isolation.

Well, those are the three basic sets, as I see it, of decision processes that need to be taken into account in any total system of instruction. Whether that system is partially implemented by teachers or totally implemented by teachers, in other words with or without the support of various aids and media, is not important. The set of conditions, I think, are fundamental to any real effort at individualization.

A part of the set of decisions that needs to be made with respect to instruction is what might be called the "medium of instruction", the type of instruction presented the student. You see here a student sitting at a teletype. This is a typewriter, usually thought of by teachers as something that has a negative value because immediately students have to learn to type. It is the assumption, and that is an additional burden. It is true that students do have to press keys, but whether they have to learn to type as a secretary, or at the level of proficiency of a secretary, is another matter. Most of the time spent in learning is time spent in thinking, not in mechanical action; consequently, the relative importance of the key board and the fingering of it is less in an instructional situation then in a work situation. So the demands of learning to use the typewriter, in terms of location of the appropriate keys, are demands which from the point of view of the learning situation, are relatively minimal. But one thing that you want to remember when you are dealing with CAI is that the computer doesn't pay any attention to what the student is doing until he signals at the end of a series of responses that he wants it to pay attentic : He hits a special key and that key permits the system to look at all he has done up to that point, process it, and react to it; hence he is not tying up a computer while he is trying to find the right keys. The computer is busy doing other things and not just waiting for the learner.

But more important educationally, now that we have talked about some of the often expressed negative feelings about the keyboard, the positive advantage is that when the learner types A, it is clearly an A, and when he types a C or D, it is clearly a C or D. Consequently the images generated on the paper and images that are clear and distinct models. In other words, the level of precision is imposed upon the learner, which from the point of view of learning is extremely important. The idea is to think in terms of these conditions with respect to the learner than those of the mechanics used.

If you do look at the conditions with respect to the learner, you will find that, in the psychological studies on typing taught to students, one of the side effects found is generally that their language skills also improved. Consequently, there seems to be more to the process of interaction with a typewriter than the simple mechanics of typing itself. This relates back to the distinctiveness of the stimuli, their usefulness as cues. The response, chaining and sequencing that I mentioned, all tend to develop in a much clearer environment with the result that learning is more precise and more effective.

Another kind of console which students use deals with a multi-media or multi-sensory environment. Here we are dealing not only with the mechanical keyboard and the learner's response to it, but we are also dealing with a visual display and the student has another response device, called the light pen. If the response is something that he presumably already knows, then one can simplify

his means of communicating by simply letting him point, or one can have him actually construct the response, depending upon which objective seems to be appropriate for the instruction. Thus, the media or response as well as the media of stimulation can be varied. This is a critical factor to be considered in terms of relating to students on an individual basis. By individualization we are thinking of systems, or teaching environments, in which the particular kind of sensory exposure of the students is dependent upon the educational considerations, the objectives, as well as upon an awareness of the particular needs of the students and their ability to cope with the kinds of material that are being presented. In this way, we have flexibility and the learning is scheduled on a point-for-point basis in small units of time. This method is more efficient than showing a film for fifteen minutes or more, then having students go off to practice before responding. The practice and or responding can take place while the individual is viewing and on a step-by-step basis. Complete recording is maintained and decisions can be exercised with respect to the logic, or flow, of strategy of the instruction. So in a sense the consoles that have been provided can be thought of as the counterparts of man's eyes and ears for an instructional system. And the computer can be thought of as the central nervous system that controls or organizes or integrates these into a totality that is cohesive, that has continuity. I want to point out to you that when you speak of CAI you should not also speak of media. A CAI system is

not a medium as is a film, or a slide, or audio tape, or video tape. It is a computer connected to a variety of devices that organizes and integrates them and puts them into some kind of systematic relationship. As a result, CAI is a system. The distinction that I am making now is between these audio-visual media that are connected up and are a part of varying system designs, and CAI the way in which we could, if you will, vary the information that is presented to students. Not only do the media make a difference with respect to learning but also the decoding makes a difference with respect to learning. Diagrams, graphs, various devices for presenting information to students need to be looked at not only in terms of their diagramatic character of visual appearance, but also in terms of what they seem to require the individual to do once he is exposed to one or the other, or is required to relate one thing to another. To illustrate, let's use some data from study dealing with some problems too of individualization. We presented a set of problems to the students; we asked these students to solve each problem using one of four rules. Each student solved a set of 40 problems, in which each rule was required equally often so that there were 10 instances that required rule A, 10 for B, 10 for C, and 10 for D. We looked at the data produced by the students and asked the question about each student; namely, which rule does the student have a better batting average with, which rule when it is appropriate is he more likely to use correctly, what's the probability of his successful use of that rule, and which rule does he apply most

rapidly, or most effectively. We had two kinds of information stored as the result of this initial experiment - (1) how efficiently a student uses the rule, and (2) how rapidly he uses it. On the basis of these two kinds of information, it is possible to set up a ratio and to say that a student has a particular pattern of performance which might be considered his optimum or best performance, given a lot of problems to solve involving those four rules. Then we have the computer generate for each student a set of new problems which fit his best performance. So if rule A then B, and C and D was his best sequence, in other words, if he tended to work best with rule A, next best with B, C and D, we would define his strategy as that sequence A, B, C, D. We would then present a new set of problems in which A was in fact more often the appropriate rule than B and B more than C and C more than D. If another student on the other hand performed best in a D, C, B, A order, just the reverse, then the computer generated a new set of problems for him so that D was the most likely solution to the problem, C the next most likely. Each new set of problems for each student thus conformed to the pattern we had observed in his first performance, and the question we then asked ourselves was: To what extent do students perform according to their best efforts? Do they learn to perform in a reliable way without explicit or specific instructions? Now we have the system adapting to each student to provide him with the best set of chances for success if he behaves in the second set as he behaved in the first,

but without telling him that. After a series of problems and solutions, we asked each student what was the order in which he used each of the rules, and we found that the students in terms of their awareness of their behavior were only about 40 percent correct, that is they c ıld tell us the order in which they used the rule only about 4 percent of the time. Actually they deviated from their first performance after we had adapted to their needs as much as 70 percent indicating that contrary to many discovery learning addicts in complex problem solving situations when the environment is made to fit their needs, students do not discover their most efficient strategy. Of course, we can't generalize on the basis of one small study about all discovery situations but at least our research indicated to us that one probably needs to provide students with an explicit description of their own performance in ways which allow them to respond according to their own ability in the most efficient manner. Hence individualization by adapta n without instruction as to the condition does not se m to be suffi cient for most learners.

There are other ways in which we can individualize. There i. the review option. Most CAI systems allow the student to go back and review slides or tapes or parts of programs. There is a "go option that tells the system to go to a particular part of slide tape if there are audio-visual devices. But the idea is to look the conditions under review as needed and to determine from the characteristics of the learner the optimum time for review with

notion that people probably need to be taught habits of review which are a part of the general study habit. We can devise more explicit ways of having the instructional material actually assist the learners in reviewing. We can remind them to review, for example, if the data were to suggest that they were at the point in learning when they are likely to have confusion or conflict with respect to the new material and the old. This is another option to teach students good habits of individualized self-study, so they can actually become self-teachers. In other words, our larger objective in this series of examples is to try to teach each student ways in which he can become more effective as his own teacher. We feel that this needs to be made an explicit part, rather than an implicit part, of an instructional program. The idea in this particular program is to tell the student that he can at anytime take notes or comment on the program so that he can record information that he later wants to review. And what we want to do here is to identify the kinds of notes the students take, the kinds of information that help them, and then to see if we can improve their ability to take notes, to summarize their own statements, so that when they go back to reread them the students can make sense of them. The idea is to first provide the capability then to study the behavior and then from that behavior to see what one would teach students so they may be more efficient at this kind of self-study activity.

Another kind of individualization of the instructional process can be used. There is a difference in the way in which students

react to the same instructional experiences. We took the same program and set up four conditions. In one condition, the material that the student saw after he responded was neutral, in the sense that it simply told him "Right or Wrong". In other words it gave him knowledge or results, but it did not evaluate his performance. In the second condition, students when they were wrong were told that [it] was a bad response, or "you can do better than that", and similar kinds of evaluative statements. A set of 14 different comments that had been scaled by judges were used to give the feedback when the responses were wrong but not when they were right. In still another group, the same program of instructions was used except that, now, when the student was right and also, to evaluate his performance, which meant that it said "That's a great response", or "you are doing very well", and such encouragning statements which also had been rated by judges as being very positive. In the fourth condition, the group received both positive and negative evaluations depending upon whether they were right or wrong, of course, so that they got the full treatment, so to speak.

I should mention one other thing. To all students we gave a personality test. You remember my pre-selection, predecision model in which the students are given different programs depending upon their personality characteristics as well as aptitude. These students were assigned on a random basis so that we did not know which student would get what one of four treatments. The question then was what is the relationship between personality characteristics

and a student's performance on the program in terms of achievement or amount learned. We found that the correlation goes from as high as a positive 35 to as low as a negative 50 depending upon the group. The relationship between aggression and attitude toward the program shows a variation from negative 50 to a positive 73. Deference, another personality characteristic and attitude toward the program goes from essentially zero to a minus 50 correlation. And deference and time speed with which they learn goes from a negative 40 to as high as a positive 48. Now I don't want to concern you with the details about the groups because my main point is simply to indicate that one kind of change seems to have a significant effect on determining which type of student, in terms of personality characteristics, dces well and what the student's attitude is toward the learning experience. It turned out for example that students who were high in aggression performed best when only negative evaluative statements were provided, no positive ones, and they also like this program better. This indicates that a student who is high in aggression on a personality test, seems to prefer a learning environment that fights back, so to speak. Now you can interpret it in different ways of course. Interpretation at this point, in my mind, was critical in that one characteristic of the learning experience can make such a significant difference in terms of student performance.

In summary, in terms of individualization of instruction, we mean not isolation but prescription personalization or humanization

taking into account the needs of the student, in making decisions about his instructions on the basis of those needs. Secondly, that in any individualization there are many factors to be considered. Some of them relate to the way in which the system adapts to the learner in sort of an automatic way, and I mentioned several of those. In other systems there are deliberate attempts to teach the student to become his own tutor, to allow him to become sensitive to his own need, and to practice those kinds of learning to identify the characteristics of the learning environment which should automatically take into account the learner, and we should also deliberately implement in our instructional program those procedures which teach the learner to become a better self-tutor. Some of the examples that I gave you illustrate some of the characteristics of these environments which seem to play an important role.

THE SYSTEMS APPROACH TO EDUCATIONAL PROGRAMS

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My objective is to explore the systems concept, to define what it means in a kind of operational sense, and then to indicate to you more specifically where this general kind of thinking takes us with respect to talks about instructions. I will use the word "system" quite a bit, and I will also refer to something that I mentioned to you last time hopefully so that they will be clearer and more useful concepts to you.

I think it is desirable to begin by saying that the systems approach means something more than systematic approach. We don't want to use this term as if it were synonymous with systematic. It is systematic, to be sure, but it has as its objective the definition of what might be called a system.

General systems theory is a relatively new development in applied mathematics which really came about during World War II out of operations research work, particularly associated with military activities. Operations research is a rather elaborate and sophisticated area in which there are many texts.

We are not going to go into this approach in detail, but this is an attempt to show with mathematical models various interrelationships among complex systems. In addition, there was an historical route in biology with an effort to organize information about biological processes.

You are familiar with the terms, such as organic systems. The idea was that there was rather separate recognition that one had to consider, not just physical entities and what they are doing. But if we can use the biological analogy, we are concerned here not only with the anatomy of the system but also its physiology; in other words, how it works.

And in fact, if we are to identify one of the more fundamental notions in the whole systems approach, it is that we should look at complex problems in ways which lead us to better identify the functions that are being performed as opposed to the identification of the objects, or conditions, or material of which they consist. In other words, in the systems approach we are looking for functions. When one designs an electronic system, for example, one specifies that he wants to amplify some sound in a systems kind of approach to the problem, and then he may use tubes or solid state circuitry to do the job.

So the physical unit that accomplished the function is a variable. It can be a variety of different physical things so the objects are not critical. They simply represent an example of the type of function that is to be performed. And one has to distinguish between the physical properties and their functional properties. For example, if I ask you to describe a car, most of you would start enumerating a collection of objects. You would start with something like the body, the wheels or the seats which are the objects. This is very natural, but I am trying to distinguish that rather natural way of looking at something that is complex from the way in which it would be looked at if one were doing a systems analysis, which would be instead to say what

a car does. It moves people or things from place to place, and it utilizes energy. It transforms energy from one kind to another kind; so one deals with a systems analysis in a very different kind of language than one deals with, let's say, an analysis of objects or a description of a systems analysis in terms of its physical components. For example, when one talks about jobs, if you talk about a job, and say, "Well, I want to hire you for a job which Mary Smith is now performing," you are in a sense doing the same kind of thing; namely, you are identifying an individual who is filling that job, but you are not telling the new applicant the things she has to do.

A job description, on the other hand, tells what the individual that fills that job has to accomplish and it is in terms of doing, accomplishing or functioning; that is critical.

So, one of the jobs in a system analysis is to first focus on the physical aspects of the problem and to identify both the functioning units and the functions they perform and to do this in terms of their critical characteristics as opposed to their less critical or variable characteristics.

Another difference from traditional approach to problem solving which systems approach represents, I think, is that with the systems approach we enlarge the problem. We don't try to reduce the problem. In fact, we are trying with a systems approach to avoid over-simplification. In other words, the systems approach is more oriented toward avoiding this error than it is upon narrowing down a problem. Emphasis on narrowing down a problem has frequently

led to misinterpretation of the problem, a failure to see a problem in perspective. Consequently, when you do a system analysis, you enlarge the problem; you try to look at the problem and the environment in which it occurred because you know that the external environment has some implications for the problem and the main point of attention. I think it is fair to say that with systems analysis the orientation is toward expurgation; the effort is to be explicit about the nature of the problem, in fact to be complete, rather than to oversimplify.

I think this is very different. It sets you up differently in the way in which you look at problems. It means you shift your attention to related matters as well as specifics of the problem, and you try to see it in terms of some total context.

Now the result of the systems analysis typically is the construction of a model, or some conception or bstraction. You come out of the analysis with something in symbolic form that represents what it is you thought you saw or that you derived from the analysis. And that abstraction presumably represents the characteristics of the problem, and is generally referred to as a model.

Now models vary, of course, in the way in which they are formulated; some are mathematical models, and in reference to operational research mentioned earlier one is typically dealing with a mathematics model. But a computer program is just as much a formalization of a problem and represents an expurgation of that

problem, for example, as does a mathematical model. The idea then is not to reduce everything to mathematics but rather to reduce to a formal symbolic structure which permits you to identify the critical features in the problem and to see their relationship.

Generally, you also are concerned with the problem of procedure because what you are dealing with for the most part are dynamic systems, systems that take place, that perform over a period of time, that consist of activities that are not all represented at any moment in time but for which a time series is needed in order to identify all of the stages of the system. Consequently, you are dealing with a time series, you are concerned with procedure or sequence, and this is where you are interested in what happens first, second, and so on.

As you know, all computers operate on the basis of a very strict ordering of things in time, and everything has to be done one step at a time. It is done very quickly of course, so it appears to be happening simultaneously.

So we have both models and procedures, and generally when you design a model for a system and look at its procedures you are concerned with optimizing something. Now many people use the term optimizing in a very loose way. But in this context it is very important that you specify what is being optimized. What are you optimizing? It's not sufficient to say you are optimizing, for when you say you are optimizing, generally you are dealing with two or more things. You want to optimize, let's say, learning and retention,

or learning, retention and transfer of the information so that the individual not only learns rapidly but retains better and is able to use the information, which means you are dealing with several things. You want to get the best possible combination, and to get the best possible combination means that you get the best of each one in the combination. You might have to settle for a bit slower learning so that you get better retention, let's say, or better transfer.

Now these things are variable, these measures that you are optimizing, and you want to combine them in some way so that the totality is your best result in a sense but is generally referred to as your optimum result. The best example that I can think of now is that you think of man as a kind of optimization of the achievements of certain things. He certainly cannot see better than any other animal. Obviously, birds can see better than he can, he can't run faster, and so on--item by item man is excelled by different creatures; but if you take the whole combination, he tends to put together a very good set. This in a sense represents optimization.

Usually systems are designed to optimize some set of things to achieve objectives. When you generate a model from your analysis, you are in a position to simulate. This means you can use the model to accomplish tasks more quickly than without it. For example, the characteristics of an instructional system can be represented symbolically as a model, then programmed into the computer to process data. One can use the model both to process inputs and to get outputs and in that way determine what would happen if various conditions exist.

You decide whether the model seems to be useful or effective, whether you want to explore what you set up from the system and use the model to produce for you, and whether you actually move them into the real world and employ them in some real setting. So your simulation, which is derived from your model, gives you a way of examining the implications of a lot of the problems that, otherwise, would be solved very slowly. Thus, simulation is a way of further exploring the validity of your model and of making predictions about what you might do in the real situation. In this way, you may narrow down the possibilities and proceed in a more efficient manner to solve real problems.

Not all modeling produces simulation nor is developed in this way and goes through the steps I have described, but this is frequently the case. And, of course, this is a very efficient way to proceed. From such simulations one can also derive procedures so that one can effect new ways of accomplishing jobs which have not been previously accomplished.

One of the big problems in achieving the state of simulation is in specifying or getting good measures of the things that we want to optimize. It is one of the big hang-ups in the whole business of systems approach to instruction, to education in general, the data, the kinds of information, or scores we get. Most people are unhappy with test scores; on the other hand, they are objective data, and one can do something with them. If they are not sufficient, then the question is what other kinds of data can we obtain so that we can

gradually move from a state of undefined specification of our scores to greater and greater specificity.

So we say we want to optimize not only learning; we want to optimize the student's attitude toward the course, whether he likes the course. This means you generate a questionnaire that tries to capture his attitude. So with each one of the things that is identified as being appropriate conceptually for us to achieve with a systems analysis, we have to back off and say how we get the data and demonstrate that we are in fact making some changes, making some improvements.

The purpose, then, of any system has to be defined in terms of these kinds of objective data, and they have to be as clear as we can get them. Systems are different in the sense th they deal with analysis of a variety of problems.

We may think of systems in terms of school management. We may think of systems of instruction or of systems which are designed to produce instructional material. These would all be different kinds of systems. But one could conceive of a larger system in which all of those systems were sub-systems, and no systems notions lead you naturally to a kind of hierarchical structuring of the environment. One can proceed either upward or downward in complexity.

In other words, beyond the fact that one is dealing with an interrelated set of functions that takes some defined input and produces some defined output, beyond that fact one cannot specify the system. And the complexity of systems is another variable which

is not quite in the systems concept but is permitted in by the systems orientation to problems. Systems analysis does not always lead to a unique solution to a problem.

I will give you a set of steps to follow in solving problems. Many of you probably know Dewey's steps for problem solving. If that is not familiar to you, he says if you want to solve a problem, here is the way to approach it. First of all you have to identify what the problem is; then you have to think about some possible solutions and identify variables that affect the solution; and then you have to translate this into some kind of operational form. Obviously that set of steps does not necessarily lead you to a solution of a problem. You may go through the set of steps and still not solve the problem, but by following those steps your batting average in problem solution is increased. You are more likely to solve problems by following that set.

Now, there are many different solutions for the same problem, in most cases. If I ask you, for example, what the rule is for long division, most of you will give the particular set of steps you were taught to believe will guarantee a solution to the problem. But that set of steps is not the only way to solve long division problems. One can, for example, solve the problem just by successive subtraction and find out how many times a particular number can be subtracted from the other. Then you just count those, and you should come up with the same answer. In fact, in modern math one of the procedures is to teach students a variety of ways to solve problems.

Now there are two basic types of systems that I think are usefully distinguished. One is called the open system; the other is the closed system. In an open system one is dealing with an input, some processing, and an output, which is the minimal set of conditions. But the output does not affect the system you are attempting to analyze, it simply goes on in an open-ended fashion. From our point of view, what I am doing is more or less open-ended or lends itself to an open-ended system analysis in that I am processing certain inputs, then giving it to you as output. But the reactions that you have to what I am saying, at least at the moment, aren't in any way influencing what I do next. This lecturing is an open-ended system.

If we talk about individualized instruction, then we typically are concerning ourselves with a closed-loop system, a system in which the response of the student does something to the teacher or the teaching system so as to modify what happens next. The thermostat in your house is an example of the closed-loop system. It tends to turn on or off the furnace or the air conditioner, depending on the time of year, in order to maintain a desired level of temperature. As the temperature varies a few degrees, the system goes on or off. But the system tends to do things that influence the on and off state.

Students turn the instructor on and off; on the other hand, one student turning him off doesn't mean that the others do also, so in the lecture situation there isn't that kind of control. But

in a responsive environment, or an interactive environment which is still more complicated, we are dealing with a closed-loop, or cybernetic system, in which the feed-back, the output, of the system itself is fed back to the system and becomes part of the input instead of total output.

Fundamentally, in instructional systems, there are three basic components; (1) there is the learner, (2) some mechanism for transformation, and (3) some information source, which might be educational materials for example. And these are, at least in my view, usefully analyzed into a set of eight components as we go down into a lower level. These relate to the diagram which I used in the previous presentation. One of the functions to be performed is the selection function; another, of course, is the input function to the learner; third is the learner himself; fourth is the output of the learner; fifth is the performance standard or expectation of the teacher or system with respect to the learner; sixth is the comparator, the process by means of which this performance and standard are related to one another; seventh is the information storage or library; and eighth is the feedback, which is the output of the instructional component and its response to the student.

It is important to go ahead to some even finer distinctions because we are dealing, in a sense, with an onion. We are peeling it after we look at the problem; we are trying to see it in its totality; we are trying to break it out into components and put things back together in a way to understand their relationship better. This is

the process of systems analysis. It is a fairly critical exercise to get the orientation that we are dealing with. Most of you, I am sure, are used to dealing with the student-teacher interaction situations in a much more global fashion. One has to do that, obviously. But if you are to understand what systems development is all about in instruction, and what the whole new look in curriculum development (i.e., CAI and PI) is all about, then I think these distinctions have to come into the picture.

Let me explain a bit with respect to selection. For example, when we are dealing with selection, you will hear such terms as linear programs, branching programs, and contingency management, which deals with things you can put in an "if-then" relationship, such as, "if this happens, then that happens" or "if he does this, then the system will do that". Now that is the fundamental way in which most of the rules of instruction can be, and ultimately should be, expressed so that we can deal with them in a fairly objective and efficient way.

Psychologically, we are concerned with the characteristics of input. We want to know what the individual should attend to, look for, be on the alert for, and want to distinguish between what's critical and what's not critical, for what's critical would be the fuse in the situation. Sometimes the problem in discrimination is just getting to know what the cues are. A person learning to read is obviously trying to do this. The elicitor function is a function to which stimulus input has to provide some immediate basis for

responding. The response may be instrumental, it may be a response that enables the individual to do something, or it may be a critical response; but in some sense it is a stimulus which elicits some kind of behavior. So the elicitor function of the input, as well as the cue function, needs to be distinguished; one has to ask questions as to which function the stimulus is performing. And if it can't be associated with any particular function, then maybe it should not be in there. If one is not sure which but is sure that it is one of the two, then probably one should leave it in.

With respect to the learner it seems to me that psychologically, at least with the present state of the arts, we are concerned with aptitude, with personality, and with knowledge as the main critical dimensions. These are broken down, depending upon various theorists, in a variety of different ways. It is largely a matter of taste as to what aptitude structures you think are appropriate, and knowledge the same way. Most people, like Guilford, have identified what they feel are appropriate ways of looking at the learner from a point of view of the psychological dimensions. So there is quite a range of choice here, and you will not find a great deal of consistency among psychologists with respect to the way in which they look to the learner; but, from my point of view, if we are going to individualize and set up an efficient structural system, we have to take into account information about the individual's state of knowledge, something about his aptitudes and about his personality.

Now output you might look at in terms of its form, sometimes referred to as the quality or various qualitative characteristics of it, for frequently these have meaning in relation to the tasks to be performed ultimately by the individual. If you use forms that are not represented in the final task which he has to perform, then one has to modify forms of presentation so that he gradually achieves a form that is representative of the final task to be coped with. One is also concerned with temporal characteristics such as latency and duration of the output that is provided to the student, the speed with which he responds, the length of time he takes to respond. Performance standards are typically translated into some statements about errors and some statements about level of improvement or rate of improvement, the level to which he will achieve, or the rate at which he will achieve a particular level. With respect to comparators, we are interested in an element by element comparison which is the way some systems work. They look at each element of the student's performance and each element of the performance standard to see how they match up, and depending upon the degree of match they provide certain kinds of information to the student. Sometimes it is just the summary or an equivalence response where the comparator is concerned with the end product of the response and not the process by means of which it was generated.

With respect to the library, this is a very active area particularly in a computer field, how one organizes the storage of information for an instructional system. Do you put things together in a man-made

form as we do in PI, which is the way unfortunately that most CAI is being generated, or does one try to develop the capabilities of a computer system so that general kinds of forms are specified but not the details? One has lists or generators which provide some of the contents, and the combination produces the display that the individual reacts to so that man does not have to generate every frame and every step. The form in which storage takes place can be within the computer and within the memory system, an electronic form so to speak; it can also be in film and video tape or these can be mixed in a variety of ways for the form, the organization and the sampling of contents. If you teach fractions to a student, for example, you don't teach every fraction possible; you select some fraction deliberately in accordance to some plan. When you get through, someone can look at the fractions you use, and you will have limited that set. That is true of any spelling set, of any examples of concept; there is always some selection mechanism operating. So the library is the result of the notions about forms, organizations and the sampling of contents.

Feedback generally consists of information that has a reinforcing function. Information does, in fact, inform in the lay sense of information, not in the communication sense of information; and it also has another aspect which you might call motivational. So when you get feedback while you are learning, whether you were right or wrong, it would decrease the probability that you would do the same thing again if given the chance. If you use information that expands the

knowledge you have about the learning situation or about the task and it motivates you in either a positive or negative way, each of these dimensions is more or less important and is given more or less attention depending upon how you, as the author, or a programmer, sees the system is formed.

Now when we talk about tasks we generally distinguish in an analysis of learning situations between learning tasks and performance tasks. In all tasks, we are concerned with accuracy and quality and with rate and quantity. These are measures which we generally derive from any task. But when we are dealing with a performance task we are mainly concerned with the stability of the individual performance, the reliability or consistency of his performance.

On the other hand, if we are dealing with the learning task, we are interested chiefly in change. For instance, one is learning when he has altered his behavior, when he has progressed from a given point to some other point. Rather than stability, we are looking for change in learning tasks, so one can often determine whether or not the individual has put the label on, whether or not he was in fact defining for himself, or for the student, the performance task or learning task.

Now what kind of change you look for, of course, can vary, and sometimes in learning tasks we are looking for changes in rate, not in accuracy, where in other learning tasks we are interested in accuracy. Which measure you look for first is also important. Your

program may be set up first to produce accuracy and then an improvement in rate.

Now that concept, that sequence when applied to the typing task, tends to be erroneous because, if you strive for accuracy initially in typing, the response which the student makes are not the same kind of responses that he makes when he is performing at a high rate. To increase his rate of speed he has to shift to a different kind of response, a more ballistic type of movement coming from the wrist; whereas, when he strives for accuracy, he uses a finger movement. So you are really teaching him a different skill when you move up to high speed. One has to worry about whether or not there is this kind of transition going on; and if it is going on, then the question is whether you aim first for accuracy or for speed. Many typing teachers say, "let's let them make errors initially and get the right speed, then work on errors;" so we strive for speed before accuracy. But this is contrary, I think, to a lot of practice.

Instructional objectives as we state them in developing a program is part of our synthetic process in going from an analysis of an instructional task to a synthesis of it. When we define instructional objectives, we are in fact defining both our performance standards, which should be specified definitely, and our error standards, which are a part of the performance standard, and the level of improvement standard. That's all tied up in one set of conditions that one is concerned with, and, secondly, we are concerned with the specification of the information content. Within the performance standard, we are

talking about the levels; the quality of performance, the kind of improvement, or change as well as the status or specific response.

The next step is frequently one of specifying the modes of instruction or the ways of specifying or breaking down, making clear or explicit the way in which the mechanism will work. To use more conventional terminology, we are looking at the rules of teaching or those that teaching will use. This is where your theory of instruction, your concepts, get translated into some kind of action. If you don't have a theory, and this is the way you are going to teach, you are still committing yourself to a mode of instruction. Presumably, then, you are really implying a kind of theoretical concept so you don't avoid the problem.

There is a variety of modes of instruction. I like to think of the modes in the following way, and I make two levels of distinction. The teaching level is the level at which what is useful in learning theory is applied to the instructional process. At the first level, the teaching level, I distinguish six levels or modes of interaction, and it is with respect to these that learning principles are used in varying degrees. The first mode on the teaching level is drill and practice. In drill and practice we define a sequence of things that a student will do to set up a definite order, and then proceed to give him experiences in which that order or sequence of events follows consistently from problem to problem; from drill to drill, and from practice session to practice session. These are highly structured.

The second mode is system control. With respect to systems we are always concerned about the loci of control, and with drill and practice we are dealing with system controlled experiences, or teacher specified experiences, where the system is simply carrying out the bidding so-to-speak of the teacher.

A third mode is problem solving. Here we are dealing with low structured materials; for example, we are dealing with the situation in which the learner knows the language of the computer, say he knows whatever language his computer speaks, and he has a problem. The learner defines his problem, writes the code, or enters the information to be processed as well as the rules for processing, now using the computer for solving a problem. This is why I say it is a low structured situation. The student at the computer has the capability to process anything in this language that he puts in, and as long as he obeys the rules of that language, the grammar will generate an output for him. But he does the structuring, so the system itself is not highly structured. It is structured enough to be an integrated self-structured language, but it is the problems he puts in and the structure he provides that are critical. Well, this is a learner-controlled as opposed to a system-controlled situation. The system does very little; the learner controls the environment in problem solving.

Inquiry is another mode. In this mode, one has a question, addresses it to a system, and the system provides him with an answer. The answer may be, "I don't understand your question; can

you say it in a different way?" Of course, you always have to provide for a question the student doesn't understand. Teachers all are ready for it when their students ask them questions, and systems must have that capability as well.

In inquiry, we are dealing with a moderately structured system. There is more structure than in problem solving because obviously you have to compile the data base that the individual is asking about; and one has to have procedures in the system so that when the student raises a question, information, that set of words or set of symbols, is processed so as to make the system capable of relating to what it has stored. It has the language that was involved in problem solving plus these additional features that I have just mentioned.

Another mode is the collaborative control mode in which we are dealing with a moderately structured situation and with a divided control which is shared by the learner and the system. There is question-and-answer where the student's responses are used for branching, for example.

A sixth mode is gaming. Here we are dealing again with moderate structure. In a gaming situation you are mainly interested in giving the student experience with the symbolism or representation of real world events and building up his ability to respond to these; but you are not imposing within the system a rigorous definition of the real world situation, as you do in simulation. The objectives of gaming are mainly to give the individual the

vocabulary and the response repertory, but they don't necessarily provide you with an adequate model of the real world. When you play Monopoly, for example, you learn about rents and about buying and selling real estate, but the controlling condition for the transaction is a die, or a little wheel you spin, a purely random entity.

So the thing that determines what happens next is really a random processer; it is not a model of the real world unless you want to take the view that the real world is a random sequence of events, which I suppose some people might assume. Gaming is fundamentally giving you the opportunity to interact with things like the terms of physical representation. The game might consist of some of the individuals actually picking up money, doing things with it, buying and selling things, carrying out various kinds of real world activities; yet, the control of how all this takes place, the flow of it, is not through some specific model, design, or any plan but is based on some kind of random generator.

In simulation, on the other hand, the controlling factor which determines the flow of events is something which has intelligence. It may not be a good representation of the real world, but it is the best representation you can get hold of, or work with, or express at the present time, so you try to simulate as you do in training a pilot. You try to give him the dials and representation of what's going to happen when he is coming into a landing field, or taking off, and the system can represent the real world quite

accurately. You can build in the barometric pressure and the latest wind conditions and get fairly good control over it.

In other simulations like economic games where you get into control of economic systems as large as a country, we obviously have less knowledge about how these systems really work. But there are formal models that describe fairly well the kinds of things that happen, and to the extent that they are there in determining the flow of events, you are dealing with a simulation.

Of course, this is where the structure comes in, and the collaborative control comes in. From the fact that in a simulation the individual has some choice about what he wants to do and, given that he is committed or that he commits himself to those choices, the system acts accordingly. The system will do different things depending upon what the student does. So if you specify that he must take off under certain conditions, he will get certain kinds of experiences that are different from specification of landing; or, if you are talking about international banking in an economic simulation, he will get different kinds of experience from that in dealing with household finance and budgeting of a family entity. Or, if you are dealing with simulations of a biological system for medical purposes, you will get very different kinds of interactions than if you are dealing with biological simulations that represent let's say a pharmacological or biochemical interaction.

Those represent what seem to me to be useful distinctions among varieties of modes of interaction, or ways in which the mechanism I

referred to earlier is defined; and these are ways in which for instructional reasons we try to relate to students and try to provide them with some change, some learning experience, some basis for altering their performance and responding at another level.

PROGRAMMING SUCCESS FOR THE UNDEREDUCATED ADULT

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A. Introduction

1. Philosophy and Rationale for Using P.I. With Undereducated and/or Disadvantaged Adults

a. Goldberg states that the disadvantaged learner has little preparation for recognizing the importance of schooling in his life, and that early difficulty in mastering the basic intellectual skills which the schools and thus the broader society demands leads to defeat and failure, a developing negative self-image. While it is not universally true that the undereducated and/or disadvantaged adult has not seen the importance of education for his own life and that of his offspring, it is frequently the case that such persons do not feel that they can make it in the world. The fact that someone knows the education is essential to his own and others' well-being is no guarantee that the motivation and confidence necessary to enter an educational program to remain in it and to succeed, will be present.

Programmed instruction is intended to generate more efficient and effective learning by breaking information down into a logical step-by-step progression, by providing immediate knowledge of results, by moving from simple to more complex material only after the responses of the student indicate that he is ready to move on, and so forth.

The individualization of instruction and the self-pacing features of programmed instruction have proven to be highly effective in enabling students to master a large amount of information and skills in a relatively short time span. The successes reported with the use of P.I. for teaching children are many, and will not be discussed here. Programmed instruction, however, is particularly well-suited for use with adults, whose experience in educational settings has been negative, incomplete, or both. The adult commonly has a long history of failure in educational settings, and, in some ways, is more difficult to educate than the child. Aside from lack of information and skills, the typical undereducated adult is "turned off" by education; he has experienced failure and punishment in learning situations before. Why should he expose himself to these aversive conditions again?

Clearly some kind of motivational procedures are called for to demonstrate to the undereducated adult student that education can and does "pay off", that there are positive aspects to learning. Of course, the big "pay off" for education is rather delayed; this may take the form of better jobs, more income greater prestige, better education of children, and so on. It is necessary, but not always sufficient, to promise these kinds of rewards for participating in educational programs. Additional kinds of rewards, more immediate than a distant job, are needed. Programmed instruction is well-designed as a motivator, as well as a teaching device. Students working with P.I usually get a high percentage of frames

correct. In contrast to their often aversive earlier educational experiences, it is eye-opening to see the confidence resulting from correct answers to program frames.

b. P.I. allows students to move at their own pace. Students whose knowledge base is poor, or who have a very slow and deliberate learning style, will not be left behind, as is the case in the usual classroom situation. This does a great deal for one's confidence and for generating an environment which maximizes learning. P.I. also may function to reduce stressful competition among students. When using P.I., there is no necessity for other students to know how fast another student is learning, nor the degree of accuracy of performance. By utilizing P.I. we can avoid punishing students, either in front of a class or in private conference with a teacher, both of which may be extremely distasteful to any student, even more so to an undereducated student who has a history of failure.

It is often the case that students' spelling, vocabulary, punctuation, and mastery of subject matters not covered by any particular program improve as a function of working with P.I. In order to perform effectively on programmed materials, students have to pick out key words and phrases in program frames. Careful reading is required. Thus it is not only the precise subject matter dealt with by a particular program that is added to the students' repertoires.

2. Adapting P.I. for Use With Undereducated Adults

In order to structure an educational environment which fosters learning, it is also necessary to insure that the vehicles of instruction, namely the learning materials and procedures utilized, are tailored to the student population. There is more to individualizing instruction than allowing students to work at their achievement levels, and so on. Because the undereducated often are members of sub-cultures which are "disadvantaged", it is necessary to take into account their cultural backgrounds, in order to develop skills and knowledge and to motivate students to strive for further education.

As an example, the names, activities, settings, events, and phenomena referred to in programmed materials (all learning materials for that matter) should be those with which the students will be familiar. Therefore, if students come from Hispanic culture, such as Mexican-Americans and Puerto Ricans, concepts and events should be related to their backgrounds and experiences. One should also not lump different sub-cultural enclaves together and treat them as if they were similar. This means that educational programs aimed at Pueblo Indians, such as the Hopi, would differ in many ways from programs aimed at another tribe, such as the Navajo. Each group, the Hopi, and the Navajo, has a different cultural background, has different world views, has experienced different phenomena, and so forth.

We can attack local problems such as sanitation and housing by gathering baseline information and then including frames related to these problems in programmed materials designed specifically for a particular sub-cultural group. It is possible to combine the teaching of, say, English grammar, with instruction concerning the alleviation of bad sanitation. This is not to say that frames relating to a community problem will be sufficient to eradicate the problem. It is simply to say that by using topical information in program frames, we can attack more than a single concern at a time. This is but a single possibility for imaginative and useful adaptation of learning materials to the student population.

Because the various sub-cultures within the United States have prohibitions and tabus unique to them, a determination of these should be made prior to the structuring of an educational program. Students should not be asked to emit behaviors which are incompatible with rigid social observances in their sub-culture. To unknowingly include material of this type could prove harmful to the overall educational program, to the student-teacher relationship, and to the student himself.

It is probable that a number of you will be in charge of or involved in educational efforts aimed at students from differing cultural backgrounds. It is maybe the case that learning materials which are adapted to particular sub-cultural backgrounds are not commercially available. It may also be possible to redo commercially-prepared programs and to tailor them toward particular sub-cultural enclaves.

In any event, the importance of such efforts for successful education cannot be stressed too strongly. The experience of the country of Chile provides an example of the way in which standard attempts to educate may have to be abandoned in favor of efforts which take the cultuve of the students into account. Chile wished to instruct pregnant women in prenatal care. They found that the women equated education with childishness. Since they didn't see themselves as children, they refused to be educated. Solution: Chilean people placed great prestige on social clubs, since these were associated with the upper middle and upper classes. Therefore, the Chilean government, through public health centers, arranged to have classes held in private homes, and provided tea and cakes. In this club-like atmosphere women began to attend classes!

If black students want only to study "Black History," this in itself should be no barrier to moving the focus to other areas of concern. By building upon students' interest with Black History it is possible to teach numerous facts and disciplines using this as a base. Science, mathematics, social studies and other topics can be taught in this manner, since all are part of Black History and therefore legitimate matters of concern. What is needed is appreciation and knowledge of cultural variables which may affect learning.

B. <u>Relevant Research Done by Author</u>

A five-year research project sponsored by the Army Medical Research and Development Command, and undertaken at Guadalupe, Arizona from July 1, 1963 to June 30, 1968, used operant conditioning procedures in community development activities. The town of Guadalupe is composed of Yaqui Indian and Mexican-American residents. The purpose of the project was to develop new methods for analyzing and influencing the behaviors of persons living in small social units. We had to determine environmental variables affecting individual and group behavior, and once these variables were identified and classified, develop a behavioral repertoire in the local population which would facilitate community development.

Developing the population's confidence that they <u>could</u> be instrumental in improving their community was a key problem. As a result of a long history of failure in their relationships with the world-at-large, the people exhibited a marked lack of self-confidence, which greatly lowered the probability of their achieving their goals. For example, the people said that since they knew so little about the English language, and other important kinds of information, that they would never "get anywhere". It was necessary, therefore, to devise strategies which would, first, build confidence and, second, develop the behavioral repertoire (such as facility with the English language) necessary for a successful community development effort.

The project operated on several fronts simultaneously. One aspect dealt with gathering baseline information regarding social organization, political structure, and economic and religious activities, and then using this information in shaping community development. A second aspect dealt with an educational program carried out under controlled circumstances. The educational program began approximately one year after the starting date of the project or following the gathering of baseline information, and continued for approximately two and one-half years.

The population asked that English training be given high priority, so I designed a programmed text on English grammar that was specifically tailored to the students' background where feasible. Spanish names, e.g., Juan or Maria, were used in place of Anglo names. The situations described were those with which the students were familiar, and descriptions of the physical environment and objects (such as cars) were in keeping with the experiences of the students. Finally, care was taken that material contained in the frames did not violate the mores, norms or ethic of the students. Knowledge of the anthropoligical aspects of the population of Guadalupe was required in order to effectively tailor the learning materials to the students.

Graduate students in the departments of anthropology and psychology were used to staff the program. Class size was limited to four or five students, in order to facilitate face-to-face interaction of student and teacher and to allow more time for

analysis of student responses. Prior to beginning work with students the staff of three teachers received training in the anthropology of the town of Guadalupe.

Seven students, ranging in age from 17 to 40 years, participated in the educational program. Examination of their scores on standard tests, such as the Stanford and Metropolitan Achievement Tests, and the Nelson-Denny Reading Test, showed that the students possessed, on the average, a fifth grade English repertoire. The average student had completed about five and one-half years of school.

Particularly in the first classes of an educational program, each class should contain at least one "very good" student. This person serves to demonstrate to the other students, who might be skeptical of their learning ability or the necessity for education, that persons such as they can learn and that there is a payoff for their efforts. The performance of the "very good" students helps prevent discouragement among the other students.

Standard teaching methods were deemed inapplicable because our students were universally "drop outs". One factor in their leaving school was exposure to educational products which were not tailored to their backgrounds or experiences. Our students told us that they had a great deal of trouble with tasks assigned in grammar school because the terms and concepts described in these books held no meaning for them.

The content of their education and the manner in which they were treated by their grammar school teachers led to the development

of avoidance behaviors on the part of the Guadalupe students. One approach to decreasing the aversiveness associated with learning situations was a series of tours around the Arizona State University (at Tempe), where the research project was headquartered. Students visited chemistry laboratories, zoological displays, and so on. On these occasions professors gave informal talks to the students. We often took students to campus coffee shops for get-togethers after class. Our students mingled with University students, dispelling some of the mysteries of University life and studying. Some of the younger students began to inquire about the possibility of being admitted to college and what would be expected of them if they were admitted. Verbal behavior such as "I would like to go to college and learn to be somebody" increased. Attending classes at the University functioned as a very effective reinforcer; there was high prestige in b[illegible] able to say "I study nights at the University".

The English program draft devised for the Guadalupe students served as a very effective confidence builder and teaching device. I constructed the program in two levels. The first level, containing 1500 frames, dealt with basic English grammar. The second level, containing 500 frames, dealt with reading comprehension.

Students initially were quite reluctant to answer questions in our classroom. The basis for this characteristic of the students may be found in both their culture and as a result of

their earlier experiences in school. Deference to "superiors" is a common trait among disadvantaged persons in Guadalupe. The verbal abuse meted out in elementary school for failure to respond properly reinforced this reticence to speak out.

The following procedure was used to shape question answering: before asking questions in the classroom setting, teachers noted the general and, where possible, specific knowledge levels of each student. As a function of interaction with students in their home town of Guadalupe and of chatting with them over coffee at campus snack bars, teachers were able to acquire a fairly extensive amount of information of this sort. When a teacher first called on a particular student to answer a question in the classroom (as opposed to the extra-classroom) setting, he asked a low-level question. By successively increasing the difficulty level of the questions asked, contingent upon the student's demonstration of ability to answer preceding questions, the question-answering behavior of the students become far more competent. Heavy verbal reinforcement, in the form of teacher statements such as "very good", was contingent upon students' answers. If the student was wrong positive reinforcement was withheld.

If students were unable to answer questions, this could lead to rapid loss of these weakly-developed behaviors. Therefore, the first questions were those that were determined to be answerable by each individual student. At first numerous prompts were

supplied, such as rephrasing the question so as to provide slightly more information to the student. Later, prompts were gradually removed so that students were answering questions independent of the teacher. After question-answering was established, it became possible to ask diverse kinds of questions. While students would sometimes be unable to answer questions, the behavior had been shaped so that they continued to answer questions. This contrasted with the students' experiences in their elementary school days, in which punishment frequently followed the emission of "silly" or "stupid" answers.

1. Use of Reinforcers to Shape and Maintain Behavior

The receipt of paperback dictionaries, grammar and reference books, access to "beer busts", etc., was contingent upon class attendance and performance. In addition to the intrinsic reinforcement of correct responding in the program, these extrinsic factors were also effective as reinforcers. From initial baseline attendance levels which were irregular (approximately 50%), attendance became extremely regular (approaching 100%) following introduction of a contingency system. The students, many of whom had worked 12 hours at a physically taxing job during the day, rarely missed classes. It was a matter of pride to have perfect attendance. All students attended every meeting except when a death in the family or severe illness prohibited.

Excellent performance was reinforced by the presentation of a complete set of paperback books on English grammar, vocabulary,

and fundamentals of reading and writing English. The quality of work rose dramatically following initiation of this procedure. Performance without error occurred dozens of times after this point. Students reported that they were paying more attention to details and checking their work more closely because of the payoffs involved.

2. Results

The mean percentage of frames on which students responded correctly was 94.0 for the first level of the English program, and 96.1 for the second level. The percentage of correct frames ranged from 89.5 to 97.1 on the first level to 92.0 to 98.6 on the second level. Only one student was correct less than 90.0% of the time on the first level.

Mean time for completion on the first level of the program was 27.50 hours, or 51.5 frames per hour, while on level two the respective figures were 8.75 hours and 50.8 frames per hours. Time taken to complete the first level ranged from 16.67 hours to 37.75 hours, while the range on the second level was from 7.63 hours to 10.23 hours.

The students reported that during their school years they had rarely been correct on tests. The students' initial accuracy on the programmed materials was at approximately the 50% level. However, being correct on every other answer was a large improvement over their previous classroom performance. The students' first reaction was one of surprise upon making so few errors,

relative to past performance. Later the students' accuracy and speed increased dramatically.

Because the program progressively increased in difficulty (i.e., progressively larger step-sizes were explicitly built into the program), it is believed that the students' increasing familiarity with the mechanics of using the program led to this significant improvement in performance. On the first level a typical student required an average of 34 minutes to complete each of the first five sections, but an average of only 28 minutes to complete each of the second five sections. The average number of errors on the second five sections was only one-eighth the average number of errors on the first five sections.

Initial exclamations of surprise turned to pride at mastery of the material. For perhaps the first time our students began to gain confidence in their intellectual abilities. Interest in further education and, possibly, in gaining high school diplomas, increased greatly. They talked less of their "inferiority" and their earlier practice of avoiding things related to education changed to an active seeking of further education. The program proved to be extremely effective, not only in providing reinforcement for engaging in learning activities, but in providing information to the students. A post-test, administered following completion of the level of the English program which dealt with grammar, showed that the students had mastered most, if not all, of the material in the program. Observation of the students' speech and writing during

and after the program showed that the information acquired was being used in everyday activities.

3. Shaping Behaviors Which Have I...ediate Payoff

We found that the older students in the classes, i.e., those who had been out of school for five years or more and/or were over 22 years of age, had better attendance and performance records than did younger students. This fact has implications for the rehabilitation of school dropouts. Traditionally, programs are aimed at students who are recent dropouts. Many people assume that these persons should be drawn back into school before they drift away permanently. The longer persons are out of school, the harder it will be, so it is felt, to get them back into the educational setting.

This assumption may be far from universally correct. When we place a dropout in an educational program, the program is usually no different from what he dropped out of. Environmental stimuli and aversive qualities which were factors in his becoming a dropout are again present. There often are no more reinforcements for remaining in the remedial program than there were for staying in school in the first place. Older persons, having been out of the educational setting for some time, may have had an opportunity for the aversive nature of such settings to fade, leading to easier reshaping under quite different environmental conditions. Younger persons, perhaps very recently out of school, tend to respond with the same escape-avoidance behaviors previously emitted.

The older students in our study had an opportunity to immediately utilize knowledge gained. For example, those employed on construction projects put their newly-acquired knowledge of basic arithmetic to practical use and secured raises in position and income. Students from the ages of, say, 14 to 21 years, often did not hold jobs or held jobs which called only for physical ability, with no opportunity to put new knowledge to work on the job. Efforts at behavioral analysis and design for the culturally-disadvantaged learner should enable these persons to immediately use knowledge gained in educational programs.

This brings us to a discussion of reward and punishment techniques. All human societies make use of these. Reward may take the form of praise, appreciation, elevation of status and income, awarding of diplomas, and so on. Punishment may take the form of ridicule, fines, accusation, physical pain, confinement, restriction, etc. Therefore, the use of contingency systems as an adjunct to P.I. is a natural outgrowth and extension of this concept.

Because of the background deficits possessed by the Yaqui and Mexican-American students, it was clearly insufficient to be concerned merely with inculcating certain behaviors (such as facility with the English language). If these students were to acquire mastery of enough subject areas to attain a high school equivalency, it was necessary for them to learn faster

than was previously the case. The procedures devised for rapid shaping took into account the students' very low-level baseline behaviors.

By making reinforcement contingent or dependent upon progressively higher performance levels, it is possible to shape behavior in the direction of greater speed and accuracy. If the criteria for reinforcement were fixed, then there would be no compensation for change in the students' performance levels, and no allowance for individual differences in performance. Also, since material varies in difficulty as the student progresses through the program, there is danger in adjusting criteria too high or too low in relation to the difficulty of the particular part of the program currently being worked on.

The adjusting reinforcement schedule technique was particularly effective with the culturally disadvantaged student, since such students usually bring a poorly developed knowledge base to the learning situation. It is a means for providing reinforcement to students with very poor backgrounds who, in the usual situation, would not be reinforced until their performance reached some absolute level, e.g., "a passing mark", "80 or 90%".

C. Other Relevant Research

1. Since 1962, programmed instruction, combined with contingency management techniques, has been used to increase the educational achievement of institutionalized offenders at the Draper Correctional Center in Elmore, Alabama. The work of Dr. John McKee and others

on his staff has been extremely successful. Utilizing P.I., it has been possible to individualize instruction far more than would be possible in the usual classroom situation. The effect of P.I. aside from accelerating students' progress through a sequence of learning materials, has been to overcome the defeatist attitude of a number of inmates who expected failure in anything having to do with education. Instruction is provided from literacy training through college preparatory work. A representative of Mr. McKee is addressing the Institute, so it is not necessary to go into further detail here.

2. In 1965, Harold Cohen and his co-workers from the Institute for Behavioral Research in Silver Spring, Maryland began an educational program which used programmed instruction and contingency management. The program aimed at an inmate population at the National Training School for Boys in Washington, D. C. As with the Draper Project, the general purposes were: 1) to improve the attitudinal behaviors of the inmates, in that they typically were unmotivated, lacked persistence, and did not have proper study habits; 2) to improve their mastery of subject matter areas, since many of the inmates not only were undereducated, but were also unable to acquire information and skills very easily.

The students Cohen worked with at the National Training School were reinforced by the receipt of points for high level performance. The points could be used to buy goods or services, including leisure time, soft drinks and clothing. Other

reinforcement was provided by the social acceptance of being correct, and by the opportunity to take advanced courses following successful completion of basic courses.

Like McKee's work, the techniques used at the National Training School were extremely effective in improving motivation and developing a knowledge base. The effort was so successful that the methodology has been expanded and implemented at the Robert F. Kennedy Youth Center, which recently opened at Mortantown, West Virginia. Directed by Roy Cerard, who was Director of the National Training School, some 250 offenders are involved in a contingency-managed environment, utilizing programmed instruction as a major instructional vehicle.

4. Current work on project newgate (Pennsylvania) suggests that many persons who commit crimes simply lack motivation, interpersonal and social skills. Although many of these persons have the potential to finish high school and college, they usually drop out of school. Once convicted and sent to prison, they rarely take advantage of the limited educational programs made available within the institutional setting.

Faculty and students of the College of Human Development at The Pennsylvania State University have undertaken a project to help correct this situation. In a program titled, "Project Newgate", they have set out to help prepare inmates for enrollment in a university program.

Project Newgate began June 1, 1969 at the State Correctional Institution at Rockview. During the first year, 50 trainees will be selected from the six to eight thousand inmates committed to the Pennsylvania Bureau of Corrections and county jails. Preference will be given to inmates with high potential and poor academic records; to the poor and those from broken homes; to those with short remaining sentences; and to blacks, who make up about half of the prison population.

Of the 50 inmates selected during the first year, it is expected that at least 10 will be advanced enough to complete some college level courses and be ready for a full-time academic program on a university campus after their release. Three Penn State professors will teach basic college courses in English, biological science, and speech. Once on a college campus, the trainees will be provided with a stipend sufficient to cover full expenses including fees and tuition for their initial term.

Another 20 students who have finished the 10th and 11th grades will receive intensive college preparatory instruction and will take at least three college courses before being admitted to college.

Twenty other students classified as under achievers -- persons who have not completed 10th grade but have high potential for learning -- will be encouraged to perform college preparatory work. At the end of the project period they should have high school equivalency and be able to meet college admission standards.

Trainees in the project will be motivated to achieve their educational goal by a system of rewards for high-level performance. There will be "payoffs" for more rapid and accurate mastery of information. The payoff will be in the form of points, which can be used to obtain items such as clothing, candy, trips to campus, and access to entertainment. Successful academic performance may also generate such rewards as self-satisfaction, feelings of adequacy, mastery and success -- feelings which most criminals and deliquents sadly lack.

In a new educational building at Rockview, trainees will be taught by the latest techniques in programmed instruction. Information will be presented step by step by teaching machines. Each new frame or unit builds on the preceding ones. Whenever new information or concepts are introduced, the student is tested on his understanding of what is presented. Depending on his response, he is directed to move on to more challenging material or to review the lesson. In this way, trainees move along at their own speed.

Four full-time instructors will be on hand to supervise and give preparatory instruction in English, mathematics, science, and social studies.

Pending legislation in Pennsylvania promises to permit involvement of selected offenders in "off-grounds" classes and programs. Qualified prisoners in this project will be permitted limited involvement in the University's social and cultural life.

Tours of the campus, and participation in drama, art and music may be utilized as reinforcers and motivators for the trainees.

Students (both volunteers and interns) will be utilized as academic tutors, discussion leaders, and counselors.

In some cases, senior student counselors may be selected to live with prisoners in an ordinary house on the prison grounds. Trainees will attend academic classes full-time at a University after they are released.

D. Prescriptions

Some methods required for projects using P.I. with under-educated adults:

1. Need to work with pilot groups of 5 or so students at first. After testing-revision cycles with these and other students, if the method pans out then expands. We need the same kind of testing-revision cycle for the try-out of contingency-management or reinforcement procedures as we do for the programmed materials themselves.
2. Need for baseline information on students: a) sub-cultural differences; b) differences as a function of training, education, etc. An example of the latter is the kind of information secured from the Scholastic Aptitude Test, Metropolitan and Stanford Achievement Tests, and others.
3. Need for fine-grain data collection systems. Need to see the effects on speed/accuracy/retention of P.I., and contingency systems.

4. Need for widespread application of concept of successive approximation. Learning in so called "simpler" societies, e.g., American Indian, is far less formalized, and relies much more on successive approximation. Example: economic attainment is carefully graded from simple to complex, so that, in a hunting culture, a child is carefully guided to making a capture of a very small animal with a miniature bow and arrow before he is guided to the next size of animal. Working with undereducated and/or disadvantaged adults, we need to use successive approximation in depth.
5. Need for anthropologists in educational activities, in designing, implementing, and analyzing. Of 1,000 staff members of the 20 education research and development laboratories in the U.S., there is only one anthropologist (to my knowledge), and he is leaving for a University position.
6. Teachers of undereducated and/or disadvantaged need anthropological training and experience, as well as training and experience with sub-culture of the kind they will be working with.

E. Wrap Up

Programmed instruction has a natural affinity to programs designed to educate undereducated adults. It can, as the examples I have cited show, be extremely effective not only in rapidly providing a full education, but in providing incentive or developing confidence and a feeling of success in learners who sorely lack this

commodity. When combined with a contingency of reinforcement system, such as those previously described, P.I. can be that much more effective.

COMPUTER TIME SHARING IN AN ADULT BASIC EDUCATION PROJECT

Miss Sue Stephenson
Regional Training Offices
Head Start
Morehead State University

The first operation of our program at Morehead State University started with one terminal located at the laboratory school on campus. The main objective of our demonstration project was to try this type of instruction in a rural setting. It proved very effective and we were funded to go on with this as a full time operation during the summer of 1967. We operated 36 terminals through the summer, connected only with the elementary schools. The program came from Stanford University to our small computer which in turn operated the 36 terminals located at University Breckinridge Training School. Participants in the program consisted of students in grades 1-6 at the training school, Upward Bound, and Neighborhood Youth Corps. In addition we conducted a demonstration project with a few adults, which was the foundation for starting the adult program in the fall of 1969.

In January 1968, the program changed hands. With the changing of administration, our 36 terminals were placed in different schools in the area, so we had 29 centers located over the eastern Kentucky area, one terminal in each school. Of course, the main objective here was to see what type of results we would receive from the community, administrators, teachers, and pupils.

The main trouble that we encountered was due to the fact that there was only one terminal in each school and it proved to be difficult for a class of 35 students to utilize one terminal. This problem was worked out by taking half the class for one semester and the other half the next semester.

Our largest school is the furthest away (115 miles) which added to the difficulties. Some other difficulties were involved in working with the various telephone companies. With the programs scattered over a wide area any terminal trouble was a problem, for getting a technician to each school in a day's time was difficult. In our teacher training we tried to discuss some of these problems so the teacher would know how to handle the problem and to help us in this respect.

Teacher training in the eastern Kentucky area consisted of a number of workshops held for teachers who would be working with CAI programs in the fall. Our program consisted of five workshops involving over 100 teachers. In these workshops we tried to give teachers a brief orientation to the program, an introduction to what they would be doing and how to integrate this program into their classroom activities. We discussed behavioral objectives and the teachers were given a chance to work on a program of their own to decide exactly what they wanted in a classroom and how to go about getting it. Along with this we had a session where they could participate on the terminal themselves as if they were

students. This is always interesting because adults are more afraid of the terminal than the students are.

We had four areas which did time sharing. We had a time sharing arrangement with Eastern Kentucky Educational Development Corporation, the administering agent for Title III projects in our region, and the computer program was under Title III. EKEDC had contracted with Stanford for ten hours per day. Of the ten hours, eight hours were utilized by the elementary schools in the area leaving only the last two hours from 4:00 to 6:00 p.m. for use by other programs. Four Adult Education classes were scheduled to utilize those two hours. Thus, the beginning of ABE Time Sharing.

Some of the problems encountered in our operation of the ABE program were due to the fact that we began late. At one time we had all four centers with over 300 students participating. Around April the program started running very smoothly but the program which was supposed to run through June, terminated early. At the termination of the project, we had 100 participants.

We administered a survey test to the participants at the beginning and also at the end of the program. Another professor and I developed the instrument in which there were statements made by participants in some of our workshops, plus questions concerning education in general. The survey was designed to get the opinion of the students and the teachers in the area as to the suitability of different arithmetic methods used in the area. We were hoping to get a wide variety of opinions but we didn't. We concluded that

the difference between the attitudes was appreciable even though we did not have a lot of time. The fact that none of the participants were against the program was very rewarding because we were really expecting them to be. On the contrary, the students and the teachers in the area wanted to continue with the program another year.

The achievement results were taken from only a small group due to many difficulties. From one center the pre test and post test results were collected for 19 students.

Different groups have been participating in our program at Morehead. Some learners have been remedial students; these are high school students who were working on a third grade level in mathematics. Other programs have been the Upward Bound program which ran for a period of six weeks. The gain during these six weeks was eight months.

A study is still in progress to determine the feasibility of utilizing computers in upgrading the education system of eastern Kentucky public schools, colleges, universities, and vocational schools. This study involves such areas as grade reporting and administration. It was intended that the study investigate the possibility of locating a computer center in the eastern Kentucky area, hopefully at Morehead so that we would supply the area much more efficiently than from Stanford. As of now, the study has not been completed but we are eagerly awaiting the report; it would eliminate a lot of problems if it results in a new computer.

EDUCATIONAL PROJECT MANAGEMENT TECHNIQUES

Desmond L. Cook
Director, Educational Program Management Center
Ohio State University

I would like to discuss with you today the concept of project management. Let me start by outlining what I mean by a project. The first requirement is that it should have a finite time limit. (i.e. the project will terminate at some point in time usually when the objective has been accomplished.) In a great many projects this occurs when the final report has been prepared. The second requirement is that there is a wide variety of tasks and jobs that have to be done by a large number of people utilizing all kinds of resources. Just think of the magnitude of some of the things that go in developing a Computer Assisted Instruction program (CAI): You have the computer people, you have the software people, and you have specialists. Obviously, projects vary in their degree of complexity, some being very simple one-man operations and others very extended operations.

It is convenient to let the project be viewed as a system. That system must be defined. What we are saying here is that the tasks which we have to do on a project are much more like each other than they are to the rest of the environment in which that project exists. One of the major tasks in project preparation is defining the boundaries of the project or defining the boundaries of the system, and isolating the project from its environment so

that one is able to say that this is a task I don't have to do in order to get to my goal. One of the reasons a lot of projects fail is because of an inadequate definition early in the preparation of the proposal.

Projects are usually non-repetitive in nature. For example, we can think of building a school building as a project. Now one advantage in building school buildings is that we have done it often enough that we have a model for doing it. This is quite helpful, but in developing CAI, for example, we don't have all the models we need for doing this project. Basically, we won't do a project again. We might get additional funding to explore another idea or a related idea but that will be a different project. Such projects are often referred to as once-through. A good case of a once-through project is the Apollo project. But now that we have been to the moon, the goal is reached; from now on going to the moon will be a matter of routine, a continued operation.

Organizational Placement of Projects

In talking about project management, one of the topics which must be included is the way in which projects are placed into organizations. Since this condition has a great deal of bearing upon the successful operation of a particular project. In an organizational structure such as a state department or education or a university, the structure includes various levels of management, functioning departments, and organizational units. Projects can be incorporated in several ways.

The project director can be placed in the organization directly under the administrator but away from the rest of the group. In many cases this is a good arrangement because the project director has quite a bit of freedom to hire the staff he wants, to move in the direction he wants. He is fully responsible. But, on the other hand, he may be off by himself with no interaction with the institution or agency.

Another pattern is the placement of a project in an existing department or unit. In this case, the unit has the capability of doing the work; it has all the personnel needed, all the facilities and skills. But it may lead to empire building and to little or no interaction with other units.

The most common pattern which exists in a large number of organizations is what is called the Matrix Structure. Here the project is brought in and a project director is named. He is responsible for getting the job done, but does so by using resources, personnel, and facilities from many departments and organizational units. In this case, the project director can make maximum use of these people in the unit, but since he is not in a line relationship a poor authority pattern exists. He runs into things like, who is going to give the rewards (the project director or the department head;) who gives the staff member his salary or promotion, and related potential conflicts.

There are many kinds of problems associated with being a project manager too. For example, one of the principal jobs of the

project director is to work himself out of a job. He is supposed to bring the project to completion. What often happens is that when he sees the project coming to an end he is tempted to write up another project in order to keep himself in this position. So the last four or five months of one project he may spend writing a proposal for another one. Consequently, we need some way of providing a kind of job security to project directors in between projects when they don't have to get money. You can build up an extremely good staff of people, but when project funds run out, you lose all these people.

Project Manager Effectiveness

What makes an effective project director? First, the kind of educational background and experiences he brings to a particular project. Does he have the kinds of skills and abilities that he should have? This requirement is particularly important when a project deals with a special field such as medicine. Second regardless of background there are certain kinds of skills and abilities that a person should have, mainly logical skills and analytical skills. You have to be able to take something apart, and isolate the elements, and put it back together again. We find many good project managers have science backgrounds or research backgrounds. Third, a project manager should have some experience as a project director, but this is not always possible. One can get this experience as an assistant project director when he is a graduate student. We should be aware of this when we employ

students and give them this kind of responsibility during their training. It doesn't do much good to put students through a series of courses on statistics and measurements with the idea that when they go out they will be able to run projects. We have to start training them to run projects as part of their graduate programs. Finally, the project director will be effective only to the extent that the organization puts resources and support behind him in terms of getting jobs done.

Nature of Management

Many people have made studies of management over the years. Historically, you could say the field of management is about fifty years old. People who have been spending some time at it have formulated certain assumptions about what managers need from an educational point of view. These are some general ideas which now pervade a great deal of the training of managers.

First, they recognize that it is a profession calling for common training. It doesn't make much difference whether he is a public or a private agency, the manager, or director, needs certain kinds of skills.

Secondly, the most important task is making decisions. A tremendous amount of effort and energy in management is devoted to a study of decision-making processes. This is particularly true with regard to resource allocation. How does the Congress, the Office of Education, or any other agency make decisions as to how it is going to allocate the money received? It is a very big problem.

Thirdly, most management specialists say that the manager needs some idea of quantitative methods. Certainly, one of the prime reasons for this is that decision-making is always done under a cloud of uncertainty. Many people have simply made subjective decisions. Basic concepts of probability theory are needed, if only to be able to say that if we go this way we stand a better chance of success than if we go another way.

Fourth, it is recognized that the manager fundamentally has to get people to do things. Therefore, he spends a tremendous amount of time learning to work with people, handling personnel problems, motivational problems, and the like. The largest part of his time is spent in this area.

Fifth, if we have differences in managers, it is in terms of different levels rather than the kinds of skills that they need. For example, the people at the top level of a corporation like American Motors set the policies; the managers are engaged in what we call strategic planning. It was the top level manager making the strategy decision to go into manufacturing sports cars instead of staying with compacts. So the differences are only in terms of levels, which means that we don't train specialists in management; we train generalists in management so they can step in and operate at any level in any type of situation.

We are beginning to pick this up in the field of education. Some of my colleagues in the field of educational administration are no longer talking about training the elementary school principal,

the junior college administrator and the secondary school principal. They are saying that there are enough common skills so that these people could step into any level of education and manage the enterprise. In our own institutions, we are making our students go over more and more to political science, economics, and other areas to get their training to be administrators.

Functions of Management

Historically stated, four major management functions have been identified. Actually they are interrelated one to the other but we generally refer to them separately. (1) Planning refers to determination of objectives and alternatives. (2) Organization refers to people, resources, and equipment associated in some kind of structure to help carry out the plan. (3) Directing means getting people to work, the reward structure, the problem of how to deal with creative researchers in organized environment, and similar personnel problems. (4) Control refers to those actions that are necessary to adjust the operations to the plan. This is a basic idea; since it is an adjustment mechanism in a sense. It is not punitive. It is not negative, but if we set off to go to Chicago we begin to digress, we had better find a way to tell us we are digressing and get us back on the track before we go too far.

When we talk about projects and the work that goes into them, we find that there are two functions that are a concern to us: One we identify as planning, and the other we identify as control. In reality these functions are very closely related and it is

hard to separate them. We talk about planning and controlling, since, the project manager's major responsibility centers in these domains.

Project Planning and Control Steps

In looking at a project, we can identify a series of steps the director goes through. The first is to set a goal or end objective for the project. Then, given the goal, we have to outline the series of supportive tasks or jobs that are going to help one get there. Outlining the series of tasks is nothing more in the long run than an objectives/hierarchy which is called project definition. Once this definition stage or hierarchy of objectives has been outlined, we know the what and why of a project. Then, we go into the work flow or plan which is a process of outlining the sequence or order in which the jobs have to be done moving from left to right.

Then, we establish a schedule in terms of getting the project done by a certain date. The reason we do this task is because we can relate costs or budget to time and, therefore, we can plan and control costs and time at the same time.

These several steps constitute what I call establishing the shoulds. This is what we say should be happening; these are the goals we should be accomplishing; this is the work sequence we should be following; this is the budget we should be following. We then proceed to enter control phase. Here we get periodic progress reports of what's going on in the project. These reports tell us

what is actually happening. Now, the project manager's job is to take what should be happening and compare it to what is actually happening, and to identify where there are deviations. Where he finds significant and decisions that are necessary to get the project condition to where it should be. To do this, he may exercise the option of even changing the should.

There are, however, not many choices he can make. Many of the discrepancies will be negative in the sense that the project might run behind schedule, or it might be running behind on performance. On the other hand, the project could be running ahead or have what we call a positive deviation. Things could be going better than they should.

This is what is meant by project planning and control. In carrying out these functions, the manager is constantly making decisions regarding the goals that are being achieved, the plan that is going to be used, the schedule that is going to be maintained, and what measures of performance are going to be secured.

Information, Decisions, and Project Management

We know many things about decision making. We know for example that it involves making choices among alternatives. We know that we must specify the objective of the decision before choosing the alternatives. We know that information is needed in order to make decisions. The project manager needs information. One of his major problems, of course, is to determine the kind of information the manager needs in order to make decisions effectively.

The question is, "What kind of information does the manager need in a project situation?" Most people have generally identified the three major categories of (1) time, (2) cost, and (3) performance as the critical information he needed. Information about time should occur in the planning stage. He can then look at the schedule in terms of where he actually is. Is he running behind or ahead? Cost is preparing the budget and checking expenditures against this plan to make sure he is not over-spending, or under-spending, or spending too fast, or too slow. By performance we mean quality control, making sure the objectives are being achieved, and that he sets out to accomplish what he said he was going to do. It is the qualitative dimension, if you will, as opposed to time- and cost-dimensions.

Someplace or other there is a nice place to balance out these three dimensions. It is very interesting to think that at any given time a project manager has to deal with time, cost, and performance concurrently.

Let's say that I am in a project situation and a certain problem comes up. If I want to maintain my schedule or keep time constant, then I can begin to play with cost and performance. On the other hand, if I want to maintain performance the only variables I can play with are cost and time. If I have a budget constraint, that is fixed price contract, the only things I can play with are time and performance. Now you begin to put a constraint on any two of these and you begin to get into a real problem. This

might occur when a schedule date is to be maintained and a budget to be set, the thing you begin to play with is performance. Think back to the Apollo program. They chose in a rather deliberate sense to constrain performance. They wanted a system which would guarantee a safe return almost 99.99 percent. They weren't too much worried about the cost or time. They would sacrifice a delay in getting to the moon in 1970 rather than sacrifice a performance.

Project Management Systems

Historically, there have been many systems developed which helped us get the project management job done. I want to review these quickly for you.

Let's assume for the moment that we have a little effort going with several tasks that have to be done. One of the earliest systems developed for this situation is the Gantt Chart developed in World War I. It outlines simply the tasks from start to completion over a time scale. Time was used because it can be related to other things such as cost. While you can show the start and completion unfortunately one can't show the interrelation between Task A and Task C. This may be a very important relationship. The other difficulty with it is that we recognize we might be through a task 50 percent in time but not 50 percent in work.

This set up now often happens, so some people wanted to improve on the Gantt Chart developed what is referred to as milestone charts. You identify within the tasks certain significant points of accomplishments and refer to these as milestones.

This enables us to mark off particular points of accomplishments so we can see whether or not we are proceeding on schedule. We are still not able, however, to see the interrelationships of one task to another. Gantt and Milestone systems were developed for production operation situations - manufacturing of cars, turning out nuts and bolts, and the like.

Starting in the 1940's, a new phenomena was occurring. We began to see the development of the programmatic effort to reach a particular goal. The goal set out was to develop a nuclear device. People, agencies, resources, from all over the country were brought together to achieve that goal. What happened in the late 1950's is the development of a new management approach caused by the need for better project control. This led to a new variety of systems which are not known as network techniques. In this system, we have our milestone events, but also, are chute show the interrelationship. Program Evaluation and Review Technique (PERT) is probably the classic example of this type. PERT was particularly developed for use in the research and development situation. Certain dimensions of it take care of the problems of uncertainty, but one has to be a student of the system to talk about it.

Projects in Education

What we have been trying to do is to take a lot of this kind of thinking and put it together for use in the field of education. We are saying the project is a system. A project proposal is a simulation or model of the system. You are trying in the project

proposal to outline the future. You are modeling it, you are simulating it; you are saying, "Give me the money, and this is the world that I am going to create out there." This is what that project will look like. Of course, the better you can do that, the more successful the project is going to be. The less you are able to do it. the less you are able to model that future. In a sense the better you can do it, the fewer problems you will have.

Let's apply systems thinking to a project as shown on Figure 1. In this particular example, the objective in a project is very close to what we call the mission function of a system. In the project planning we have what we call definition where we outline or break out terms, the function, the product, the sub-system. This is very similar to the factoring or decomposing that goes on in systems. Once you decompose a system, you put it back together again in terms of a synthesis and this becomes a plan. Notice in systems analysis column there is not scheduling dimension but there are feedback loop interactions. I have generated what I call a general project management model as exhibited in Figure 2.

There is a basic overall system or totality. This totality can be broken out into two major sub-categories, one called the planning system and the other called the control system. The planning system is set up to outline the way we go; the control system is a vehicle to make sure we are going that way. What too often happens is that somebody will do the planning but nobody is

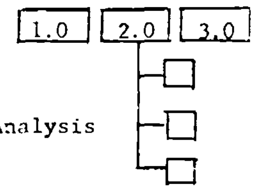
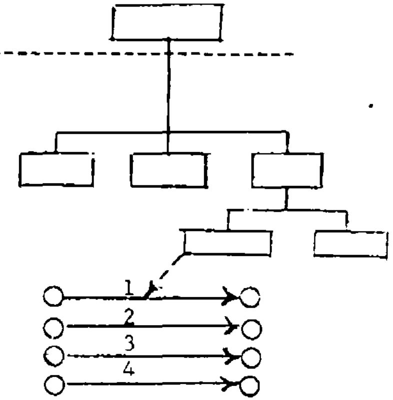
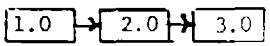
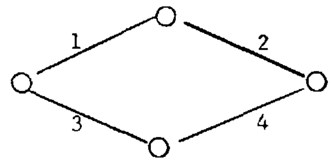
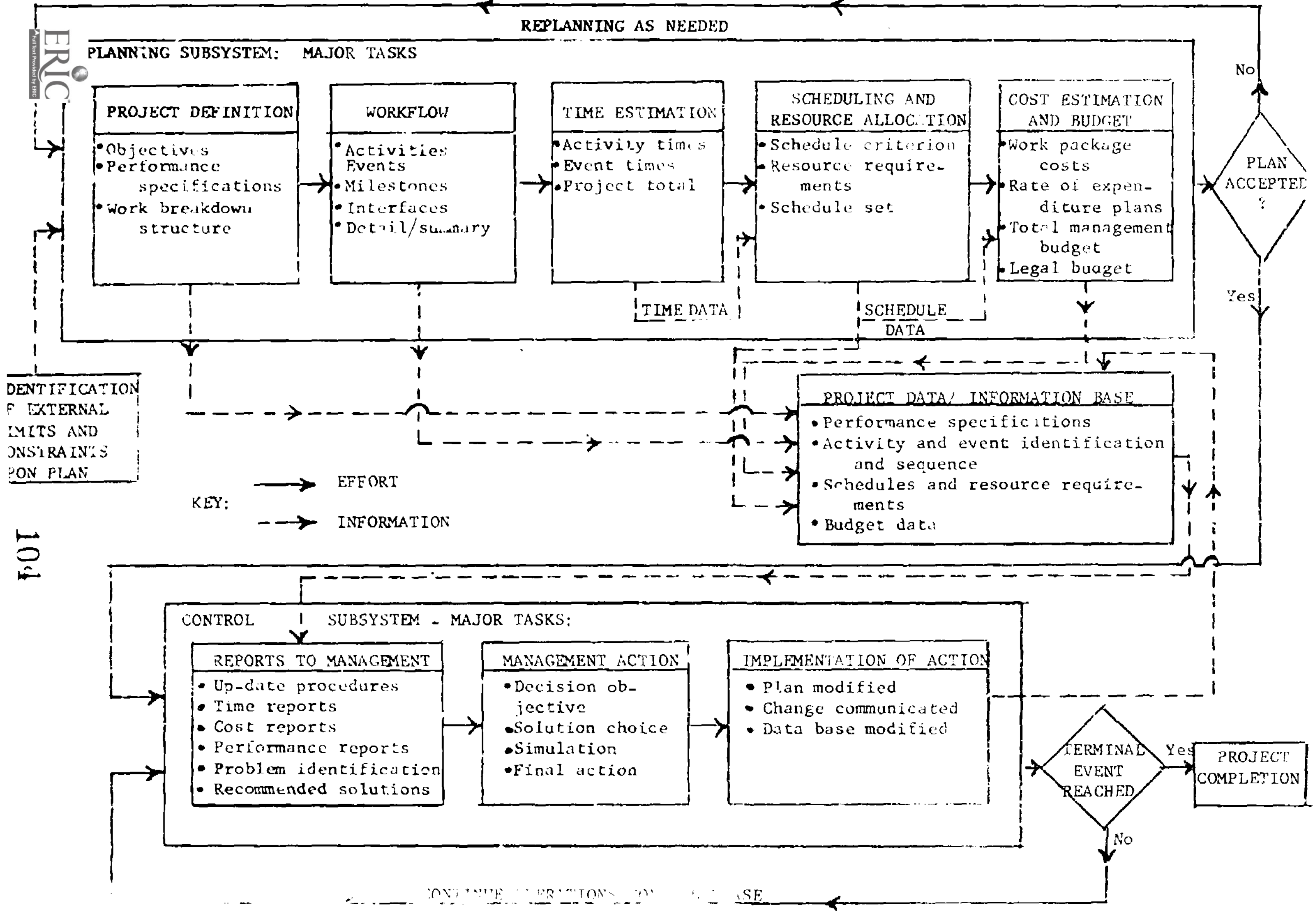
System Analysis	Steps in Project Planning and Control	Management Systems (Network Based - PERT/CPM)
A. System Objective - Purpose	Project Objective(s)	Objective
B. System Analysis by hierarchial factoring into levels of functions Profile: Functional Analysis 	Project definition in terms of subsystems, products, functions, and so on	Workbreakdown structure Activity (task) definition (means-end) 
C. System synthesis through flow graph methodology (functional flow diagram 	Project plan	Network 
(No Provisions)	Scheduling	Activity time estimates, event times, slack, resource allocation, etc.
D. System Feedback Loops Iteration	Controlling-Evaluating	Deviations, Management Actions, Decisions, Recycling

Figure 1. Schema for integrating system analysis and management systems with project planning and control steps



and controlling of projects

really controlling anything. On the other hand, we have some project managers exercising control. They are worried about the budget, the schedule and so on but you look around for the plan and none exists. That kind of situation would be like just getting in your car and suddenly driving down the street not knowing where you are going. Both of these go together. If you plan something, you intend to control it. If you control something, then there should be a plan.

What's involved in planning? Basically we identified five sub-systems. The first of these we call project definition which is the outlining of the goal of the project, moving from large parts down to small parts. We use terms like factoring, decomposition, analysis, disassembly. What you do is take a global task and try to break it out into its constituent parts. This is where your systems concepts become quite useful to you.

Let's now take the technique of Program Evaluation and Review Technique in the right column of Figure 1. We can relate to PERT and show how it fulfills each one of the planning and project control ideas and also to systems analysis and the way we are using it here. In the PERT system, there is a major objective to be accomplished and you develop what we call a work breakdown structure. This is hierarchy factored just as it was over in the system column. We can eventually break out smaller and smaller tasks which we eventually call activities. We then take these activities and put them together in a flow graph which we now call a network.

Where PERT differs from systems is that with PERT we now produce time estimates t d the job; we establish what we call slack conditions for management purposes. Then in the controlling function, you take care by noting the deviation that occurs between what should be happening as outlined by the plan and what is actually happening, taking those actions which are necessary to correct the thing and then recycling to get back by establishing a new set of "shoulds" or by revising the existing "shoulds".

A Model of Project Management

What I have done over the last several years is to study various project management systems and asked, "Why can't a project director develop his own system?" If he understands what is going on, what the functions are, then he is not bound by one particular technique. One of the problems you have is that people can see the same global thing in different ways. What a staff has to do is agree on some kind of structure before they can move ahead. The main thing here is the outline of the task. Once tasks are outlined we put them into a flow. Once we get that done we go on to time estimation. Here is where you run into some interesting problems because, if it is a R & D situation, you are going to have to develop expertise with what we call probabilistic systems. You are going to have to recognize that unplanned elements can happen and there is a need and a way to protect ourselves on that. Scheduling is a matter of setting up the resources we need and when we want them. This gets to be a real problem. I have seen a lot of

projects run into trouble because the managers were thinking they could get a consultant at a certain point in time when they needed him but they had failed to check with the consultant. So they had to delay a certain vital part of the project until the consultant was available or else get a different consultant. In many cases a different consultant has not had the same quality and consequently the project suffered. So scheduling is a real problem. Budget preparation comes last. It is done after the others are accomplished. Many times I have reviewed proposals in which I wonder if the same people who prepared the budget prepared the rest of it. It is very hard to see the relationship between the work to be done, the objectives to be achieved, and the budget.

Under control systems three points were emphasized. The first point is that if you are going to control you do this through a report system. There is an expertise just in this particular thing. I would say to you first of all reports have to be on time. It doesn't do any good for a man to know about problems too late to do anything about them. Second, they have to be brief, and if at all possible they should be visual. They should be written up in graphic form so that the problem can be readily identified by the manager so he can see what he has to deal with. Make it very simple, one or two pages. If you then want to supplement it with necessary appendix material, go ahead. Second, the report identifies the problems to which the management give his attention. Using problem analyses techniques, he works

out a solution to the deviation from plan. Third, having made his decision, the manager must make sure it is implemented.

Summary

The general model presented covers the basic dimensions of project management in education. Proper understanding of the basic concepts and principles will give some assurance that you can be a successful project director or manager.

References For Further Reading

1. Russell D. Archibald and Richard L. Villoria, Network-Based Management Systems, John Wiley and Sons, Inc., New York, 1967.

2. Wallace Clark, The Gantt Chart, The Ronald Press, New York, New York, 1922.

3. Desmond L. Cook, PERT: Applications in Education, Cooperative Research Monograph No. 17, OE-12024, 1966. U. S. Government Printing Office, FS5.212:12024.

4. James C. Emery, "The Planning Process and Its Formalization in Computer Models", in Joseph Spiegel and Donald E. Walker (Eds.), Second Congress on the Information System Science, Spartan Books, Washington, D. C., 1965.

5. Paul O. Gaddis, "The Project Manager", Harvard Business Review, 37:89-97, May, 1959.

6. C. J. Hitch and R. N. McKean, The Economics of Defense in the Nuclear Age, Harvard University Press, 1960.

7. William H. Huggins, "Flow Graph Representation of Systems", Operations Research and Systems Engineering, John Hopkins University Press, 1960, pp. 609-636.

8. IBM Application Description, Project Management System 360, Program Application H20-0210-0. International Business Machines Corporation, White Plains, New York, 1966.

9. R. A. Kaufman and R. E. Corrigan, What Is the System Approach, and What's In It for Administrators, paper presented at the Symposium on the Application of Systems Analysis and Management Techniques to Educational Planning in California, Chapman College, Orange, California, June 12-13, 1967.

10. "Naming 1,000 Educational Innovations", Phi Delta Kappan, Vol. XLIX, September, 1967, p 36.

11. David G. Ryans, "System Analysis in Education", Technical Memo, 1968, System Development Corporation, Santa Monica, California, July 9, 1964.

12. Martin K. Starr, Production Management: Systems and Synthesis, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1964.

13. Ira G. Wilson and Marthann Wilson, Information, Computers, and System Design, John Wiley and Sons, Inc., New York, New York, 1965.

COURSE AUTHORING TECHNIQUES FOR CAI

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When I first joined the International Business Machines company I knew nothing about computers and couldn't understand what people were saying. Every second or third word sounded like "byte" and "bit" and "index sequential storage". It was a completely different language that sounded like English but failed to make any sense.

After I had learned a little about the business I recognized that the language was indeed English and made sense provided that I spent time studying it.

The point is the people who work around computers have a jargon all of their own, and unfortunately, this jargon is recursive; that is, if you don't know one term you are prevented from understanding by context other terms which follow.

I would like to start today by skipping through a few definitions with you so that we may jointly have a common basis of understanding. A glossary is by definition a list of terms in a special subject, or field, or area of usage with accompanying definitions. Gilbreth's definition of technology is the most satisfying I have yet encountered: The systematic application of scientific or other organized knowledge to practical tasks. We use a similar definition for education technology is the application of technology to education, i.e. the application of an organized body of knowledge (a technology) to a practical task, in this case education.

Instructional technology is a subset of educational technology. Here we are talking about that part of education which is known as instruction. Instructional technology is the use of technology, the use of organized knowledge, and in this case the practical task is to improve the student's interaction with his materials, the subject matter, and his teachers.

Instruction is: interaction between a student or learner and (1) learning materials, (2) subject matter, the discipline itself, and (3) the instructor, the individual who is available to interpret and help him understand, his teacher.

If I take that same definition of Instructional Technology but change a couple of words I have a useful definition of Computer Assisted Instruction. If we cross out the words "instructional technology" and replace them with "CAI", instead of speaking about technology generally; which would include such things as audiotutors, video tape records, books, films, or tape recorders, these other tools; we talk about the use of a computer, then we have: CAI is the use of a computer to improve the student's interaction with his materials, subject matter and teachers.

As we begin to look at computer assisted instruction specifically, and before we get to the question of how one goes about authoring material for computer assisted instruction, we need to look next at the varieties of computer assisted instruction. I will present these in a few groups and try to make some differentiations between these uses of computers in instruction.

DRILL
PRACTICE
PROBLEM REVIEW
DIAGNOSIS AND PRESCRIPTION
TUTORIAL
GAMING
SIMULATION
FACT FINDING
COMPUTATION
LOGICAL PROBLEM SOLVING
EXPLORATION

Figure 1. List of different ways computers may be used to improve instruction

There is no real hierarch in the list; that is, although the first item is called Drill and the last item is Exploration, this does not necessarily imply that the one application is any more useful, any more powerful, than the other.

A computer may be programmed to drill a person on requisite knowledge. It may be programmed to permit a person to practice the use of skills or techniques or it may be programmed to provide the student with assistance in problem review. These are different applications of the computer.

A number of fairly large projects with a lot of money involved have been less than successful because of the failure to understand

the difference between Drill and Practice. And yet, when you sit down and think about it, most any classroom teacher can specify this difference to you. As an example of what I mean by Drill and what I mean by Practice, consider some skill involved in basic arithmetic. If I ask you "What is 9 times 9?" I expect a response of "81". I don't expect a bunch of manipulations with numerals which lead to the answer 81. And my criterion performance of good behavior would be how quickly you emitted the correct answer and in terms of overall performance how frequently you emitted the correct answer.

Now in programming drill for a computer you write a program which will (1) include randomly all possible combinations of numbers for which the student is expected simply to know the answer. And in presenting such a program to the student, you are not much interested in telling why 9 times 9 is 81. The concerns are (1) that the student give the correct response and (2) that he give it quickly and consistently.

Practice on the other hand can be illustrated by the Problem 99 times 9? In this case the student is expected to (1) know the number fact 9 times 9 and (2) know an algorithm or procedure for multiplying two digit numbers. The exact response and the speed with which it is made are relatively unimportant.

Drill and Practice are quite different, and you don't program remediation for them the same way. If an error is made in a Drill the correct remediation is to represent the problem with the correct answer supplied. If an error is made in a Practice, the correct

remediation may be either to teach missing number facts or to teach the proper procedure. Additional diagnosis must be done to determine which.

Problem Review is another, rather different yet associated, use of computers in instruction. This is a situation where you may have a student, say you are teaching him basic science, and you ask him to calculate how quickly a body falls from the Leaning Tower of Pisa to the ground. The student is expected to have sat down and independently calculated the answer and figured out how to solve the problem. Then when he sits down at the computer terminal, you ask him a question such as: What answer did you get? If he got the correct answer you might tell him this is right. In case of error you might ask him to type the formula he used in getting this answer.

In other words you would do the same kind of interacting between the student and the computer, as you would in a classroom if you were sitting down working with one student rather than a whole group of students. Going over a student's individual problems at a terminal is an effective use of the computer as instructor.

The concept of using a computer to find out what a person knows and what he needs to know is very attractive. The idea is that you place a learner at the terminal, give him a task to do, look at the answer, watch the way he performs the task in terms of building sentences or doing problems or whatever, and then tell him on the basis of what you find out that his response is correct or send him to "other" instructional tools in order to practice the needed skill.

"Other" tools might consist of other applications of computers in instruction, CAI as well as video tapes or films.

Tutorial is the most common concept, the most commonly understood application to student instruction. This is the kind of situation where in essence you have put a programmed book on a computer which has the ability to understand natural answers. There you are engaged in a dialog with a student except that you are not really there. You are there by being the author of a program. The student interacts with a program rather than with you directly.

The tutorial concept of CAI is the oldest of all the CAI concepts. When Ralph Grubb and others first began to work with computers and instruction in 1958 or 1959, they wrote tutorial interaction so that a typewriter would ask a question of a student who would type back an answer, and the typewriter would respond on the basis of the answer provided. It is quite difficult to write effective free language CAI instruction.

It is possible, of course, simply to put in Skinner-type programmed instruction programs and let the machine keep track of the student's answers, but I do not believe there are benefits in doing so. Why use an expensive machine as a page turner?

One of the real problems of CAI, is that it is so exciting when you can program a computer so it sits up and whistles, as it were, that people tend to write programs simply because they are fun to do, not becuase they fill a need. Computer assisted instruction is as old as PI; yet even at this stage, 10 or 11 years later,

we are still in the process of trying to understand what there is about the computer in instruction that adds something that other techniques or tools do not. It simply does not make sense to write a CAI program if you can do the job just as well with a motion picture or printed page.

Gaming and simulation might be regarded as being at the opposite end of a continuum; in other words, there is a fuzzy dividing line between what is gaming and what is simulation. I think the most useful distinction between them is that a simulation is an imitation of reality whereas gaming is something one does just for the fun of it. Yet, even gaming can be used as a rather powerful instructional tool. There are a number of computer games for which one must have command of certain basic skills to be successful, such as spelling in some word games. There are games you can do which are basically fun but which require you to develop speed; in this case, it would be similar to Drill to develop quickness or the ability to apply skills in which they become similar to Practices.

Simulations, on the other hand, are the bringing of reality into the classroom or onto the terminal so the person can compress things in terms of time. For instance, one of the oldest computer games is the Sumerian game in which the student fulfills the role of the warrior priest king of ancient Summer. He has to make decisions, such as how many people shall plant the grain needed for food, how many people will become soldiers to guard the frontiers, how much of the total national resource should be put into killing rats so they

don't eat so much of the grain, and should they build rat-proof warehouses which will cost $10,000 each or wooden warehouses which cost $5,000, or do they simply sustain a certain percentage loss to rats, in sum, all kinds of decisions which have to be made in order to live in a community.

There is no possible way of providing such experiences first-hand for a learner, yet on a computer we can compress the time scale and the learner can practice making decisions. A medical srudent can practice diagnosing and prescribing for an ill patient. If he makes a mistake the patient dies. You can't let a student do that in reality; yet, with a computer, he can readily gain skills in these directions.

Somewhere between doing things for the fun of it and in imitation of reality are items which can be found along the continuum of games and simulation.

Another simulation is practice for job interviews. The computer asks a question; the student gives an answer; the computer asks another question; this situation is very similar in nature to the diagnostic materials which are used by the medical people. Yet, I think this would be very useful in the work with the under-educated people you have here at the Center.

Oddly enough, one of the powerful uses of the computer is simply to find facts. Library skills are important but once you have developed library skills you still have to go to the library and spend much time to find information. Perhaps the computer can be used to help you find information quickly and easily.

Interestingly enough, Computation is an instructional use of computers. Indeed, in the entire field of computers in instruction, there are probably more terminals being used just for computation than for all the other uses combined. A number of vendors offer a service called Basic, for which you put a terminal in the classroom where the student simply sits down and computes on it.

Logical Problem Solving, as opposed to Problem Review, is this idea of critical thinking, the process of learning how to take advantage of facts and ideas in order to arrive at solutions for real tasks. People who are concerned with critical thinking and problem solving talk about hypotheses and testing hypotheses. In ordinary English this comes out like this, "Well, let's see, that's the problem; what are the possibilities?" And so you think about the different ways that it might be explained. "I have so many dollars; I have to pay so much for rent, so much for insurance, so much for food; what is the optimum solution in terms of relative applications of resources?" You can try out solutions and get answers, then change variables and get different answers and so a handle on what would happen -- until you arive at the kind of solution that would be applicable and make sense to you.

The last concept I would like to introduce is the idea of exploration. This probably has more future and more promise in terms of the use of computers in instruction than any of the others. This is the idea of making available to the learner, in essence, all the accumulative knowledge of mankind, in a form that he can go and get as he needs it.

As I think you can see, from the list of items we have gone through, there are a lot of different ways of writing CAI courses. Some of them, such as programmed instruction on a machine, consist of no more than just putting in a series of sequential frames for the students to see, with the following frame basically determined by his answer to the previous question. Others, such as Exploration, involve somewhat different organizations of knowledge. Let's look a little further at Exploration. Figure 2 (next page) might be a model of the knowledge involved in some subject matter. The illustration is diagrammetic and has no reference to reality

As you look at any subject matter which you want to teach people, you can define pieces of knowledge. Some of the pieces are relatively small, and some are relatively large in terms of what you have to know, understand, and relate in order to get an idea down firmly.

I am sure that of the learners that come to your classes, each one brings to any experience, be it learning or any other, a widely different background, and what they know is also different. It doesn't make sense to me, then, that everybody that comes to a classroom should be taught exactly the same thing A person coming to a classroom should learn just those things that he needs to know that he doesn't already know. When you set up your criteria, your objectives, and specify critical behaviors for a body of knowledge, what you are really saying is when a person finishes studying this material this is what he will know or this is what he will be able to do. I don't think it matters at all whether every individual who comes to study a

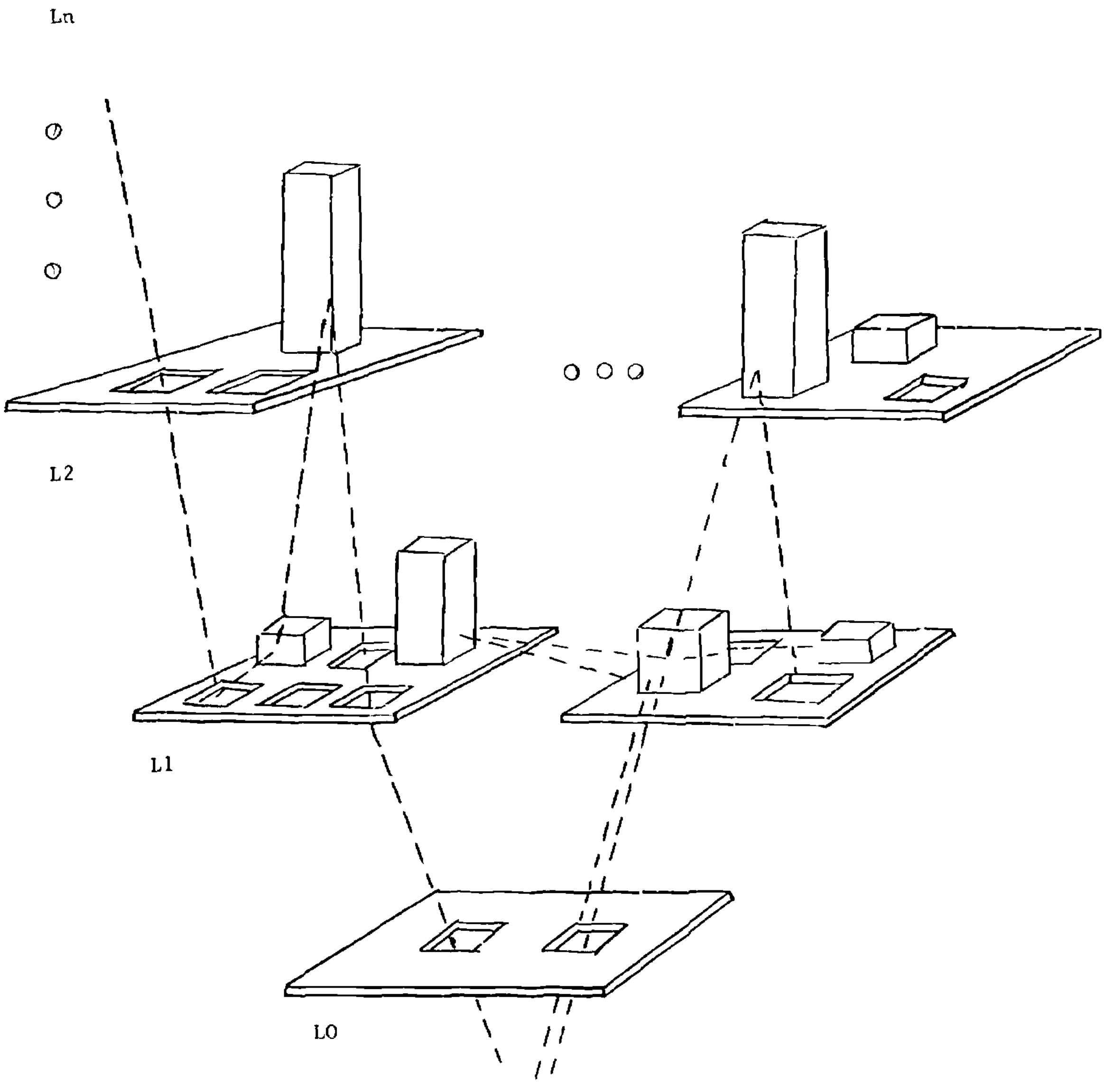

Figure 2. Organization of the knowledge available within a subject area; dotted lines show paths followed by two different students

body of knowledge reads every page of the book, or listens to every word of the lecture, or covers all the material in exactly the same way. What is important is that the person, when he finishes, is able to meet the course objectives.

One of the real promises of CAI is the ability to permit a person to study those things he needs to know. Each student should be able to go at a rate that is comfortable and meaningful to him as he progresses. In a given body of knowledge, a student may enter the course, study this material, then go study that material, be satisfied that he knows what is involved; and go take the examination or otherwise attempt to meet the criteria. Some people are very organized and will take first this and then that, other people may explore widely. Yet each one is equally happy, and gets equal effectiveness from the material. I maintain that this is the proper way of organizing material for instruction.

Let's look a little bit at the problem of writing and authoring materials for CAI. Figure 3 (next page) compares the writing of materials for CAI with the writing of any other sort of instructional materials. In either event an author is involved; he simply writes a manuscript, and when he finishes a chapter, page or unit, he then submits this material to an editor for review, revision, suggestion, and correction. This is a regular procedure, for there is no one of us whose written output cannot be improved by the assistance of some other person looking over our shoulder and pointing out to us where we made assumptions that were not valid, and the like.

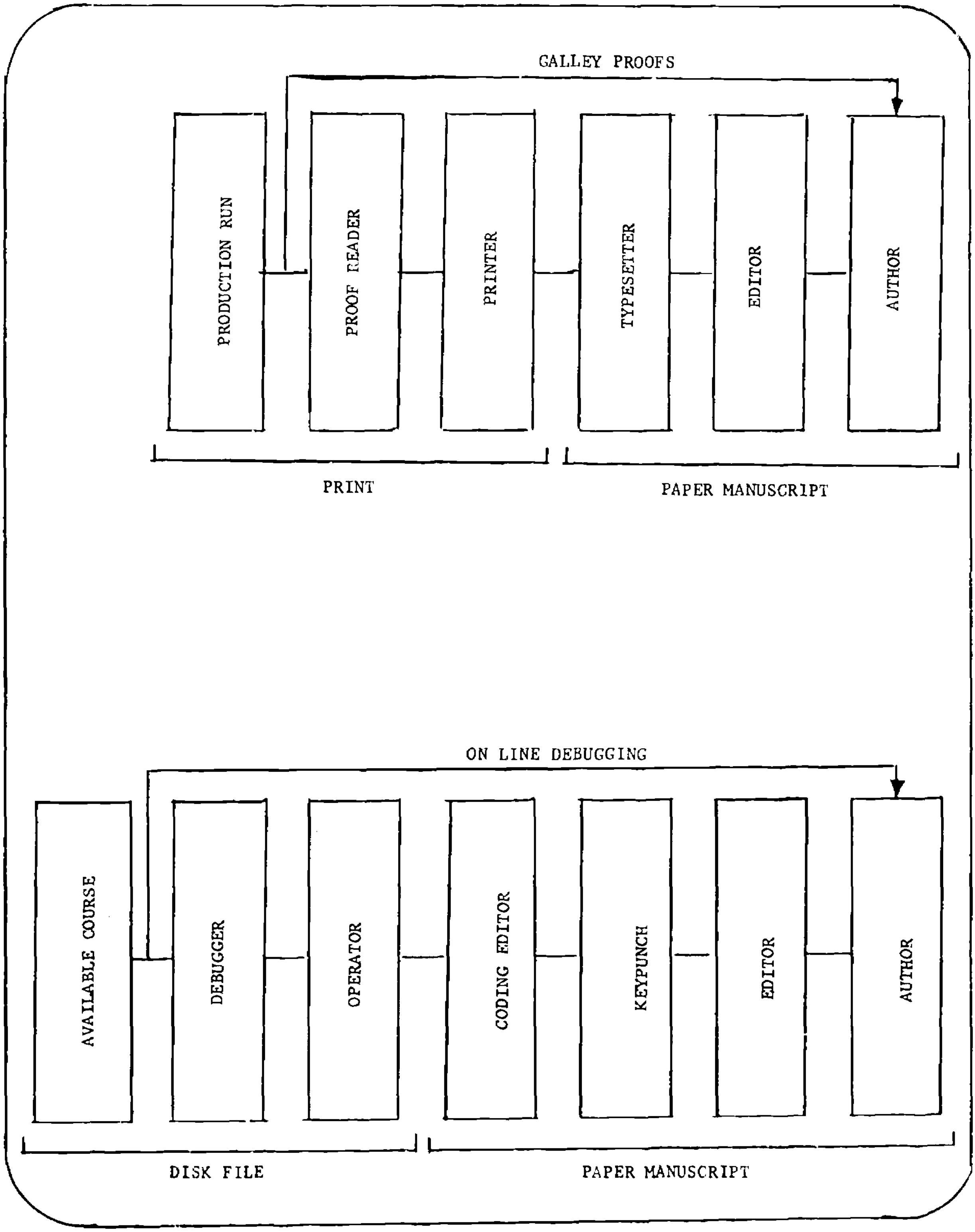

Figure 3. Comparison of conventional and CAI authoring procedures

In the usual publishing process, once the editor and the author have finally agreed concerning their material, the editor then sends the manuscript to the typesetter who is a specialist. The author, if he wants illustrations, draws stick figures or writes a description of what he wants illustrations to be, and the editor sends the manuscript off to an artist to have them done properly. After the type is set and the plates are made, the whole thing goes to the printer. Up to this point, a paper manuscript exists; from here on, a typescript will exist.

The output from the printer goes first to a proofreader, a person who checks to see that spelling and punctuation are correct; then the galley proofs go back to the author and editor for review and any necessary changes. Once the text is in print it looks different. Eventually, after everyone has approved the sample pages, a production run is made and the book exists, or the set of slides exists.

Now let's look at the CAI process. When textual material is to be used on a computer, the author's task is exactly the same as when he is writing for any other media. Just as an editor in the publishing business must know about typesetting, even though he himself may not be a typesetter, and must know about what is possible in the printing process, although he himself may not be a printer, so an editor concerned with CAI has to understand what is possible within the particular computer system that is being used.

Eventually a manuscript, a joint product of an author and an editor, is sent to a keypunch operator, whose function is to punch the data on cards so that they can be printed and entered into the machine. From the keypunch operator the finished cards go to a coding editor, a person who understands all the vocabulary used in computer coding. When the coding editor finishes, he sends the completed deck to a machine operator who loads this program to the machine. The debugger means exactly the same thing as proof-reader. Only after all these people have done their tasks does the program in the form of an on-line program go back for the author to take his own course to see how it looks. The author does not need to know the machine language. Finally, when all is done, a new course is available.

When you are writing for a printed page, a long paragraph can be continued on the next page. When you are writing for presentation by computer, if you are using television-like screens to present the material, only so much material can be put on one screen. If you are using a Teletype, or if you are using a typewriter, the machine prints so slowly your concern is for the economy of words. In either event, an author writing for CAI must be confined. We have found this form to be very useful (Figure 4 - next page). The author and his editor are concerned with the instructional integrity of the single frame presented to the student at one time. They try to get one idea on one frame. Convention specifies that every frame must have a name, so

COURSE NAME ______________________________ PAGE LABEL ______________ (1-12)

From row [|] (16-17) to row [|] (19-20) erased. [ ] (22) Restart point? Check if required.

TEXT
(6-71)
(72 is continuation)

Pause Time in seconds (73-80)

A or F

Columns

		0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	
	0																					
	2																					
	4																					
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	26																					
	28																					
	30																					

(1) (3-7)

After this frame, the student should go to:

[ ] The Return Point

[ ] The Next Logical Frame

[ ] The Last Question

[ ] A Frame Named.... [ ] (1) (3-15) ... Group identifier . [ ] (1) (3-24)

(You may enter a 2-character response identifier)

Enter E, K, N, C, P or U.

GO TO ________ if his [ ] response was ______________________ [ ] [ ]

________ if his [ ] response was ______________________ [ ] [ ]

________ if his [ ] response was ______________________ [ ] [ ]

________ if his [ ] response was ______________________ [ ] [ ]

________ if his [ ] response was ______________________ [ ] [ ]

________ if his [ ] response was ______________________ [ ] [ ]

(1-12) (14) (16-71) (75) (76)

when you write for CAI the concept of naming things is important. You name every frame that you present. One way of naming things is simply to number them.

When a frame shows up on the CAI system, the page number will be called a label and will be the identification needed by the machine to enable it to present the frame to you when you ask for it.

After the student has seen a given frame, there are several things that he might do; for example, he might go on to the next page. In this case, all the author needs to do is specify by a simple check that he wants the student to see the next page after he has finished with this page. If the student is to go to a different page, all the author does is indicate the name of that page in the space provided. But if the student is to go to a frame that he is to select, then the author indicates that the student has freedom to make his own selection.

On the other hand, it may be that the next page the student sees will be determined by the answer he gives to a question on the current page. If that is the case, the author provides at the bottom of the form a decision table. This is basically a little chart that tells the machine to send the student to page "X" if his answer was this, or page "Y" if his answer was that, and so on.

This is a general authoring system for any CAI system. Notice that, in order to use this system, the author does not have to know a computing language. All the author has to do is understand how to

present ideas to learners of the age, ability, and skills that will be using the material and how to think logically. It is the concern of the coding editor to get this material into a form acceptable to the machine being used.

In addition to the written presentation on the screen, and the decisions concerning the answer, there may be associated with each frame audio messages to be played, and if it is audio, you specify the name of the message. He might also want to see given frames on a projector, images which are prepared for presentation, color photo material which is best done on a projector as opposed to a CRT type screen. Notice that the decision table permits the learner to go to this frame if his answer was this the first time he gave it, but go to that frame if his answer was this the second time he was given permission to answer.

The output from one of these frames is a manuscript consisting of many pages. An advantage of a paper manuscript is that it defines what is going to be seen on the screen; it shows what will happen on the basis of any answer a student gives.

MULTI-MEDIA PROGRAMMING

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The technology of instructional programming grew up tied to the printed word, in the early teaching machine presentation devices, and in programmed textbooks. Well over 95 percent of all programmed materials presently available still take the form of programmed printed materials. There is an obvious conclusion to be drawn from this: programmed instruction is a "book-bound" method of instruction. But that conclusion is not correct; instruction--including programmed instruction--can take many forms, and can utilize a variety of media.

Many articles have described programming as a "process". Actually we should make a distinction between two processes: the instruction itself is a process, interactive in form, requiring active responding by the students, and providing confirming or correcting feedback or evaluation; and the design and development of the program is also a process, a process that requires objectives - the operational definitions or specifications of the desired learning outcomes - and an empirical developmental process of testing and revising the instruction to make it achieve the objectives. These two processes are as applicable to any other medium as they are to the printed word.

When we look at media from the instructional design point of view, we should do so with objectives in mind, and ask ourselves what kinds of stimulus inputs can be used to facilitate, clarify, and make more comprehensible either the responses themselves, or the stimuli to which the student is to learn to respond. Although we cannot go into the complexities of this approach, it should be clear that this is quite different from the more typical and more casual approach of selecting a variety of media on the basis of relevant content and availability! Typically the rationale for construction of "multi-media courses" is the principle of redundancy. The teacher tells and shows, and assigns text and reference coverage of the same material, and then brings in a variety of audiovisual presentations to present the same information all over again in a different form. This is generally a "shotgun" approach that has very little systematic or professional expertise applied to it. The approach says, in effect, "Since no one approach seems to do the job for all students, we will subject all students to all repetitious presentations, hoping that as a result, they will all learn." This is a part of the basic instructional approach that has always dominated public education, an approach that concentrates on content and information presentations as the design emphasis, rather than on an approach that concentrates on changing behavior by specifying that behavior and then building whatever content and instructional interaction that an empirical approach finds to be necessary.

It is possible to program any instruction, whether that instruction is presented by a teacher, an audio tape or video tape, a film, or a textbook or workbook. But the programming process - at least in its initial stages - is the same, independent of the media that might eventually be selected. The objectives must be identified, and so must the entry level competencies of the students, in relation to the objectives, and in relation to the media selection possibilities. We need to ask what stimulus inputs are relevant to the objectives, either as stimuli to which the student must learn to respond, or to teach the student about the stimuli and related responses. And we have to consider the capability of the student, and whether a given medium will facilitate or hinder. Practical considerations are also important, those considerations of convenience for student and for the teacher, as well as cost, and equipment availability and operation.

The "language lab" is now a fairly common application of audio tape for instructional purposes. I spent a year working on a research project at the Defense Language Institute's Language School at Lackland Air Force Base in Texas. One of the very first language laboratories was developed there a number of years ago, and the decision to employ audio tape for language instruction was a perfectly sound one. At the Language School, English is taught to foreign students - English as a foreign language. The School does not have instructors who can teach foreign students in their own language. All teaching, explaining, and instructing is done in English, building on the very slight proficiency that the students bring with them. It is a fascinating

structure of instructional design problems. Audio tapes provide drill and practice, and, in some of the newer materials, language development itself. Audio tapes - particularly in cassette form - provide a potentially powerful instructional tool, not only for language instruction, but for instruction in many kinds of other subject matter areas. But most language laboratories are only partially effective, and very inefficient, and some of the materials used are almost unbelievably bad! The medium is not so powerful as to be able to make a poorly designed or irrelevant "instructional exercise" into a highly effective and efficient instructional tool. It should be obvious that the same is true of films, television, books - and lectures.

Research and development and empirical course development projects have indicated clearly that intuitive, logical, a priori media selection and design are simply not adequate. The inadequacies are not as readily identified in the more conventional courses, since it is assumed that the course structure is adequate, and that all inadequacies identified by course examinations are in some way the fault of the students - and the students pay for it. But the empirical approach directs evaluation attention to the components of instruction as well as to the students, and revisions of materials can eliminate the bulk of the inadequacies - of which there are many - previously blamed on the student.

Multi-media courses, and multi-media programs for segments of courses should make use of the empirical development model and

specifications of objectives. This does not mean that when that approach cannot be fully implemented that the old "redundancy principle" and the "interest value and change of pace" principles are inappropriate. Sometimes we have no choice. Sometimes redundancy is the only available expedient, and multi-media variation can make courses more interesting. But since we can be more precise and more effective, and more relevant in our use of instructional media, those shopworn "principles for media selection" should be second choices, and more accountable methods should be used whenever possible.

Individuals involved in the empirical development of instruction, whether for "live" instruction, "packaged" instruction, in education, or in training, have utilized flexible programmed lectures and programmed demonstrations, programmed laboratory work, and programmed independent study. It is unfortunate that the computer and its terminology has led to an unfortunate interpretation of the word, "programmed". Many people respond emotionally to the word, thinking of it as referring to something inhuman and inhumane, mechanical, stifling, and contrary to the values of creativity, intuition, and insight. In the instructional sense, programmed instructional materials and presentations are those that have been designed to provide interactive instruction, to achieve specific objectives, and do so reliably and predictably. The do much more, and well-developed programs can stimulate interest, curiosity, and creativity, and develop competence, and self-confidence. Other kinds of instruction can also

do those things, but neither conventional nor programmed instruction will always do it unless creatively designed and implemented. And, I believe, this requires accountability through all phases of design, development, and implementation.

Implementation, surprisingly enough, is not our strong suit; that is, the plea for more precise specifications in the form of objectives does not in any way imply, "We know how to teach; what we need are better specifications." The bulk of activities called teaching are little more than presentation methods, except in the lower grades, where interactive instruction is a necessity, or nothing much happens (actually, it is a necessity at all levels, or very little happens, and accountability won't work in an environment in which teaching is no more than bombarding the students with information). Elaborate or simple presentations and performances based on only vauge notions of the kinds of competences to be developed in the students, confounded by a failure to direct and guide student interaction, appear to be a rather unprofessional and casual way to go about something as important as instruction! We do very little to improve our chances - and our students' - from that point on. Frequent progress evaluation and remediation might help save it all, but, again, there is very little of either except at the lower elementary level. We don't seem to care about finding out what is happening to our students on a day-to-day or even a week-to-week basis. Tests that might help us diagnose student difficulties often are so widely spaced as to leave the students in a

cumulative failure position for weeks or months before the diagnostic data are collected. But then the diagnostic data are not used for diagnostic purposes - not in any systematic manner - nor is much done that could be called remedial instruction. Described in those unflattering terms, our instructional implementation procedures are not very impressive.

The term, "multi-media programming," is of temporary value only, to refer to the programming process applied to the development of courses of instruction involving a variety of media and methods. But it is the programming process -- not the multi-media aspect -- that is the more important. Objectives, interactive instruction, and validation (testing and revising until the course achieves its objectives) can be applied to any medium, any method, and to any combination of media and methods. The implementation methods required to make each component of instruction do its specified task might be the single most important development in education during this period of innovation and change. We have learned how to do it in small, special projects; now all we have to do is learn how to do it on a broad front and on a large scale.

A MODEL FOR PRESENTATION DESIGN AND MEDIA SELECTION

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In the early days of programmed instruction we naively believed that the produce we were developing was so innovative and so powerful a learning device that as soon as it got into the hands of the students they would cry for more. Any means of reaching the student, even by door to door selling would lead to an overnight revolution in education. So we thought. We were not alone in this supposition, for by 1963, something like 200 teaching machine - programed learning companies had been formed. One year later, most were bankrupt. All of the bright, eager advocates had neglected one item - we never really questioned how PI material would be used in the classroom. Failure was rationalized. It was fashionable to blame the classroom teacher for being resistant to change and fearing replacement. But, the negative reaction of teachers stemmed not so much from a fear of being replaced, but rather from a reluctance to implement something which did not really fit in the present educational system.

The resulting "bust" in the PI business produced many casualties. However, a few professionals still clung to the belief that behavior psychology could contribute to education. Some continued to write PI, others wrote on how to write PI. And some of us began to see if we

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could design methods of incorporating our materials into the existing or modified educational system. For this latter activity some useful information had been collected resulting from the testing of our previous programs. PI fortunately allows one to observe each step of the learning process. So, we began by taking these observations and generalized them beyond the tight stimulus control of the frame to broader concepts of an educational system. Individually prescribe instruction, contingency management, and educational accountability are examples of these extensions. Most recently this research has led to the development of the media or presentation design model which I will now discuss.

We are at the present time testing this model at the U. S. Naval Academy under an Officer Education Grant. It is a significant research project which requires well over a million dollars in its implementation. Its objective is to determine exactly what effects various educational media produce. An important collary to this question concerns the cost-effective considerations of methods and media.

We first had to come to grips with the problem of defining what educational media are. An examination of the research on media is very disappointing. Attempts to classify factors that could be tied to media was almost hopeless. It appears that those educators who favor certain media do so more for emotional reasons than because of any research results. In fact, the research on media is so disorganized that anyone who is trying to put together

a multi-media package is almost forced to rely on personal preference. We all talk about the grand advancement of multi-media and mixed media educational systems, but there are no rules for mixing media or for the design of multi-media courses. This state of affairs led us to attempt a different approach.

For this, my engineering training came in handy. A medium in an engineering sense is that which transmits something. Every medium has limitations that modify your delivery some ways. For example, the diameter of a water pipe acts to limit the flow at a given pressure. In engineering, we examine the limitations - not the advantages of a medium. Might we not examine educational media in a similar fashion? We may assume that any educational medium limits us in some way. It "cuts off" in certain predictable ways some aspects of the message. The "message" in education is not just the content but includes the form of the "package" as well.

Let me illustrate the point. Let's consider this presentation form: (1) Information is to be presented in a verbal or illustrated display, (2) a demand of a written or selected response is to be made, (3) the presentation will last as long as the student desires it, and (4) a student must respond before going on to the next item. It is important to note that I did not specify any educational medium. Although certainly the choice of media we may use is effected by the presentation form. As you may recognize, this presentation form is a standard PI form. It usually is implemented via a work book, but it doesn't have to be. The PI [illegible] have become very

inventive and have used other media such as slides and tapes to implement essentially the same presentation

Let's look at that presentation when we try to put it through the single medium of motion pictures. We find out that condition (1) can be met, but condition (2) is not since there is only a covert observing response demanded in response to this medium. Condition (3) is violated - the duration of the presentation is preset, is not available as long as the student desires it, since the next presentation occurs no matter what the student does, condition (4) is not met. This example clearly indicates what we mean by limitations inherent in the medium. A movie cannot convey this presentational form intact.

Let's take a more sophisticated device - the human tutor. A human tutor alone cannot present stimuli in anything but a verbal form. He can demand a vocal response, because he can hear and the student can speak. The presentation lasts only as long as it takes the tutor to speak the words so there is no way the student can linger over these stimuli. Condition (4) can be met by the tutor demanding that the student must make some response before proceeding. Clearly, the tutor is also limited in presenting the PI presentation form. If, however, instead of the tutor alone we use mixed media presentation which involves the tutor plus the blackboard and a writing tablet, we can convey our original presentation form intact.

Now what are the important characteristics of the important presentational forms? As I said, we first attacked this problem by listing every factor we could think of. This included attitude, atmosphere, color of the walls and more than 200 other factors. We soon decided we had enough so we began to analyze and condense them. We finally narrowed the factors down to six which we felt directly influenced learning. We found these six dimensions formed three classes: (1) stimulus class, (2) response class, and (3) what we call an instructional management class. These classes vary in two very important ways; in form and in frequency or rate. The dimensions thus appear as follows:

The Dimensions of Presentation

	Display Form	Duration
Stimulus	Environmental structure Pictorial Symbolic Verbal	Transient Length of time the presentation remains intact Persistent
	Response Demand	**Response Demand Frequency**
Response	Covert Selective Constructed Vocal Motor Affective	Frequent Sparse

The Dimensions of Presentation (continued)

	Manager Purpose	Instructional Management Frequency
Management	Need Management	Frequent
	Achievement Management	↕
	Prescriptive Management	Frequency of decision to change presentation
	Enrichment Management	↕
	Motivation Management	Sparse
	Systems Support	

Although this structure may appear logical and simple, it took almost a year and a half before we saw these relationships coming out of the mass of variables we began with, (Tosti and Ball, 1969).

The first dimension, the display form or stimulus, can be represented in a variety of ways, but four forms are most common in education: (1) environmental structure; (2) pictorial - any illustrated information at all; (3) symbolic - as in mathematics, and (4) verbal, both written and oral. Now there are obviously other ways in which information can be displayed. One could use gestures, odors, feel, etc., but usually these forms are unimportant in education.

Suppose we decide a pictoral display is the most appropriate presentation form. We have not specified what medium we might use to convey that picture. Obviously, a book could handle a picture, so can a film or a blackboard - which one do we want to use? Perhaps, if we consider the other 5 dimensions the choice

will be narrowed. If our educational system indicates an ideal condition we would like to have for each of these six, not for just the display, we can begin to make some rational decisions on what media-mix we might use. Possibly we might be forced into trade-offs. For example, a film may be too expensive, a book too dull, and a blackboard too inconvenient. So, it might be best if we could eliminate the pictoral display. If we break the verbal information down more and thus increase the response demand frequency, we might do just as well.

Let us now examine the second dimension. Displays vary in their duration; that is, how long they will remain intact. The impact on learning of duration can be very important. Display varies from very transient to very persistent. Various media have different capacity in handling the duration aspects of the display. For example, a book cannot handle a highly transient display. While a movie normally handles a very transient display with ease. Movies, however, can also handle persistent displays. For example, there are underground films that show the Empire State Building for 18 hours.

Duration factors are frequently found, but not identified as such in Educational studies. Researchers have often compared the highly transient display of movies with mixed transient-persistent displays of conventional lectures or they have compared conventional lectures with the still more persistent PI. Inherent in all these experiments has been this confounding factor of duration. It is difficult to compare PI with lectures when the student, at his

leisure, can observe the PI display as long as he likes. Such research is not analytical when as potentially powerful a factor as duration is not being controlled.

Too much research is of this form. One of the major considerations of the Annapolis project is to eliminate the confounding of media with presentational considerations. There are many important questions raised. Is duration a factor in learning complex information? What are the interactions between presentation dimensions and what we are teaching? Or the kind of students that are learning.

Let us now consider the two response dimensions. There are a class of media that we usually neglect in our research which we might call the response acceptance media. These are media which can accept student outputs and possibly store or transmit these responses. Such media may be just as important as display media. The note pad you are writing on is a response - acceptance medium. My ear is a response - acceptance medium. Now one way in which I differ from a video tape is that as a device I have potential of accepting oral responses, while a video tape has no such potential. Even though our display characteristics may not differ much, our response acceptance characteristics do. This may be an important difference between the lecturer and the TV, but only if the capacity is used. To a lecturer with 500 students in his class, his response accepted capacity is of little use. Unfortunately, in education it is as common for us to pay for unusable media advantages.

It could be, and we are investigating this now, that the most significant single dimension of presentation is the response demand frequency. There is some evidence that the success of PI and CAI does not result from their elaborate feedback mechanisms, or their precise attempts at establishing stimulus control but, just from the high frequency with which they demand response, which causes the student to interact with the material. Our preliminary results indicate that if you can guarantee that the student is interacting with the material, the frequency with which he is required to respond may be the best predictor of success. It may also be the factor which is most sensitive to individual differences in students' abilities. We suspect, and there is tentative data on this, that some students require a higher response - demand frequency than do other students. Most of us in this room have been able to learn successfully from books, which have a relatively low response - demand frequency; however, we know of others who require much higher response - demand frequency.

We have in our own work developed instructional material which we call multi-level materials, which are really presentation variations in response-demand frequencies. The top level is usually a textual or motion picture presentation with a very low response-demand. The student may read three or four pages of material and then take a short examination on this information. Then, if he is successful, he goes on to the next topic. If, however, he is not successful, he branches down to a greater level of response - demand frequency,

with information presented this time in a paragraph form with questions after each paragraph. If he is unsuccessful at this level, he is branched down to a still lower level with the high response - demand frequency in the form of PI frames.

I must point out that response demand frequency is independent of any feedback consideration. Though feedback is often incorporated in such procedures, feedback falls in the 3rd category of instructional management.

There is a third class of media which we call instructional management devices. There are devices in any learning situation, which asses information and make decisions to change the presentation for a student. In conventional education, the teacher is an instructional management device. She listens to questions and changes her delivery as a function is assessing the student's needs. Instructional management can be very important in an educational system. We define it as the decision to change the presentation as a function of some assessment of the student's needs aspirations, or achievements.

As a lecturer, I have a preset display plan. If I were stopped by a question from the class I might change my presentation as a function of that question. If I had previously recorded my planned display on a video recorder, the system could not accommodate such instructional management. The video tape is limited in its ability to act as an instructional management medium.

Instructional management requires three procedures, (1) appraisal of the student, (2) selection of activity, and (3) initiation of that action. These activities take place in every good instructional situation. We have gone into conventional classrooms and evaluated ongoing teaching in terms of what student data the teacher is accepting, what kinds of decisions she is making, and what kinds of actions she initiates. We find, for example, that in highly engineered classrooms, there is a significant correlation between the kinds of instructional management action that the teacher takes and resulting student performance. It appears that the more the teacher overrides the system, by deciding things for the student which he can decide for himself, the poorer student performance is.

Although all forms of instructional management requires the same activity of appraisal - selection - initiation, what data to use and what activities to initiate depend on the purpose of management. We have tentatively indicated five purposes three of which I would like to discuss now.

The first purpose is called need management. This form is particularly important in remedial programs. It is necessary to be able to decide what curriculum is required to meet a particular student's needs. In the Job Corps system, students are given an achievement test battery to place them in the appropriate curriculum. Instructional management that allows the student to skip the next 15 frames if he is familiar with the topic is an example of need management.

Purpose two, achievement management, is the one which is most commonly employed. More effort goes toward achievement management than any other form. The purpose of achievement management is to insure that the student masters the desired objectives. There are a variety of ways of doing this. You may be familiar with individualized programs in which short tests are given after each presentation. If the student passes these tests he may proceed, but if he fails he is assigned different material covering the same topics.

Another form of achievement management in a computer managed system evaluates the student every two weeks. If he fails the student is given remedial instruction. In our Annapolis project, students are evaluated on a daily basis by means of a post-test. Each wrong answer requires a different form of remediation prescriptions.

The confirmation technique commonly employed in PI is a form of achievement management. The confirmation of an incorrect response indicates to the student that he had failed to acquire that information within the frame. It signals the student to engage in self management. He uses the data of his "error" to re-examine the presentation and thus remediates himself. The author has found that in one situation more than 85% of all students errors could be remediated by this procedure. Thus eliminating the need for costly branches.

Achievement management was not the original rationale given for using confirmation. Originally, we thought the confirmation acted as a reinforcer. However, we very soon found out that the confirmation

would not act as a reinforcer in the same sense that food could act as a reinforcer for an animal. It did not maintain behavior or material. With no other "reinforcer" than confirmation, the student often gave up and threw the material away.

The third purpose, motivation management, is often confused with achievement management. We are not defining motivation management in terms of interest. Many studies have indicated that interest is irrelevant as long as there is some way of assuring continuing contact with the educational environment. Motivation management is therefore defined as that which maintains student contact. Obviously, you have a situation which is so boring that students will leave or not "pay attention" - learning will be diminished. One way to avoid this is to use contingency management procedures. In contingency management we make highly probable activities, such as recess, contingent upon the execution of lower probability responses such as doing arithmetic. Contingency management is just the recognition that what one ought to do and what one prefers to do at the time may be two different events. Contingency management solves this dilemma by making the execution of the prefered activity contingent on the emission of the required activity. The instructional management procedure asseses some evidence of student accomplishment, such as the passing of a test and then initiates a high probability response such as an opportunity to take a "coke" break. Motivational management is often the most significant single factor in an educational system.

Let me describe how instructional management may work. We have a program we call the PRIME educational advancement center. We have organized reading and arithmetic materials into an individualized program. These have been divided into steps. A task within a step requires approximately 20 minutes of work. Each task is followed by short tests which adequately measures comprehension of that material.

When the student comes into our program, he first receives a standardized achievement test which is used to place him in the appropriate step curriculum his needs indicate (need management). His tasks are assigned, and he works them. At the completion of each task he takes a short test we call a progress check. If he fails a progress check test he is re-routed through a remedial exercise (achievement management).

We initially insist that the student arrange his tasks in such a way that the less preferred task precedes some higher probability activity. He is allowed a 7 to 10 minutes of break for each hour of instruction. In the back of the room we provide a variety of activities, such as coffee and soda pop, a chance to talk with friends, and card games. In other words, a menu of high probability activities. Eventually the student is completely free to daily arrange his tasks as a contract with tasks interspersed with breaks. He has agreed that he will not go on his break time until he has satisfactorily completed his task (motivation management).

Summary

It would be comforting to think that the engineering model proposed in this report would appear immediately in operational educational systems and revive the "ed biz". However, the model proposed here is neither sacred nor sufficient.

The present six dimensions of presentation design are a good first attempt to structure presentation in terms meaningful to the educational designer. Of course, the underlying philosophy in these dimensions and the whole model is that behavioral technology is a practical solution to the needs of education. Overt considerations of behavioral technology are foreign to present educational practice. But we feel that an acknowledgement of the efficacy of behavioral technology and its dedicated practice in the schools will solve most of the educators' problems (except for the equally large problem of school administration and logistics).

We discussed presentation in terms of six empirical dimensions. A continuation into procedures for selecting a presentation form must be made. Any real situation will also be finally judged in the marketplace where cost, equipment transition, and completeness will be prime variables. Much work is needed to devise and measure alternative systems which will be responsive to the demands of the market. The creation of demand for a fixed product is another strategy which the diversity of educators interests, goals, experience and their autonomy seems to preclude.

Media limitation is another research area which will ultimately produce media selection criteria together with behavioral change expectancy figures.

If media preferences really exist and if learning rates of individuals are sensitive to media choice, then some measurable student attributes must be defined which will provide media selection guides. It would be optimal to be able to derive curves for expected behavioral change versus media selection on a real-time basis for each student, and so provide material to achieve highest expected gain.

There are also significant questions regarding choice of the dimension of presentation. Does stimulus complexity have a place in presentation design or should that be a concern of the generators of the behavioral objectives or even of the writers and artists at the production end? How can the scope of a presentation form be adjusted to accommodate enough behavioral objectives to make a reasonable lesson? How can larger presentation forms be structured? The game and the real-life simulation are two forms for which the generation of objectives must be done to fit the form rather than the form depending entirely on the characteristics of objectives. How should the learner and content variables affect or be brought into presentation design?

A better definition of timing and sequencing of instructional events must be offered than appears under the distribution dimension.

If the objective of creating a presentation design technology is to provide a media-independent abstract form in order to have a theoretical base for structuring learning materials and selecting media, how can the theory really be partitioned off from its companion components, media selection, behavior objective generation and sequencing, and even basic learning theory? If the concept of an abstract presentation form is to stand and prove useful, much more effort and thought must be put into these types of questions. It cannot stand or even be put into practice using only the thoughts presented in this paper.

Finally, different sorts of problems must be solved in the practical ar. .s of teaching the yet to be developed technology of presentation design and sorting out the complexities of creating and maintaining an operational system.

The job of educating will be only half done when a system is on the store shelf. Success will be largely a function of administering a smoothly, operating system that works in the field, operating an accountable system to meet the required student goals as was predicted on paper.

COMPUTER ASSISTED INSTRUCTION: AN OVERVIEW

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My comments on CAI are based not on an extensive amount of work with adults but rather on the experiences we have gained at Florida State working with a wide variety of students. To my knowledge the group at the Center in Raleigh is the only one in the country that is dealing directly with this type of application for adult learning materials. Perhaps the most effective way to provide you with an overview of CAI, and to give you an orientation to our thinking about the problems associated with it, is to introduce some concepts of CAI and try to assess its potential role in adult basic education.

The best place to begin this presentation is to define Computer Assisted Instruction; however this is practically an impossible task since it has multiple definitions which are related to a variety of applications. It is interesting to note that historically CAI was defined by the IBM Corporation. IBM has not only dominated the field of CAI, but has in fact generated the label CAI.

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The original terminology for this interaction between the student and the computer was called Computer Based Instruction but after a brief upheaval in the IBM Corporation in the early 1960's the term emerged as Computer Assisted Instruction, denoting that it simply was a corollary tool for instruction as opposed to the primary source of instruction. The field has grown beyond IBM at this point, however, and CAI is taking an even broader connotation.

The best functional definition of CAI was derived by Syppes in terms of the three kinds of activities comprising CAI; namely, (1) tutorial mode of instruction. This mode clearly represents the type of teaching which is currently available in program instruction; that is, the content area is systematically analyzed and performance objectives are developed. The student receives all his instruction in a particular topic via an interactive dialogue at a computer terminal. This type of instruction is typical of the efforts at Pennsylvania State, Texas, University of Illinois and to a certain extent Florida State. (2) The drill and practice type of activity is clearly best represented by Syppes activities at Stanford. He has provided math and spelling materials to students by means of teletype terminals which are connected via telephone lines to a PDP/10 system. He has achieved from good to outstanding results by using the computer primarily as a presentation device. The drill and practice materials contain information which the student has previously encountered in the classroom

but in which he needs continual practice, immediate feedback, and repeated presentations of difficult material in order that he can achieve these basic skills. (3) The third area within the definition of CAI activities is that of problem solving. Problem solving is generally most like what we call simulation or gaming. Gaming or simulation is often used when a student already has the basic information about a topic, but he is required to utilize this information in his interaction with the computer in order to derive a deeper understanding of the concepts which he has learned. Economic games, business games, and medical diagnosis simulations are all typical of CAI. Games and simulations are often very difficult to program in this area and have probably been least pursued in terms of their learning potentiality for the student.

Since the tutorial mode of instruction is perhaps the one in which is most familiar and prevalent in CAI, it is worth taking time to discuss in some depth the Florida State CAI Physics Project. I will not argue that our developmental techniques, or necessarily our outcome, are typical of the general use of tutorial systems throughout the country; but I think there are a number of generalizations which we have evolved from this project which may have a great deal of bearing on how you might consider the use of the computer in adult basic education.

The computer based multi-media physics course was funded by the U. S. Office of Education in order to provide us with support to explore the possibility of developing and evaluating an automated

college physics course. Approximately 300 to 700 students enroll in the physics course each quarter and it was from this group that we obtained our students.

When the project began, we undertook two activities which proved to have high pay-offs; first, we video taped the lecture presentations of the professor who is responsible for the classroom version of the course. We utilized the tape to do an analysis of the content of the course and to determine what information was being presented to the students. These tapes proved to be invaluable to CAI writers at a later date.

In addition, in order to show some immediate activity on our computer system, we secured copies of the course tests, analyzed the types of skills that were required in order to solve the questions, and analyzed the homework that students were required to do. We set up a series of home work review problems which were made available on an optional basis to the students in the regular physics course. The students were offered the opportunity to come to the Center and receive homework test-like questions which were similar to those they would be receiving on their conventional test in the physics course. The computer supplied answers to the questions as well as remedial feedback and reinforcement.

You can imagine what it was like the first time we entered the class of 700 students and offered this service to them. We had to explain in three minutes what CAI was all about, and why they might want to come down and participate. Out of about 700

students only 30 volunteered to participate. The second time there were 75 to 80 who came down; and by final exam time, the Center and its terminals were saturated for nearly a week prior to that exam, processing approximately 280 students. This was tremendously encouraging to us in that the growing number of students indicated that in their minds we were providing a service that was of some importance to them. A great deal of data showed us where the problem areas were. We were able to identify those concepts in physics where they were really having difficulty. We used the video tapes and this student base line information to go about the development of the individual lesson sequence.

I think that it is important to note from these early activities that, in general, it is unwise to develop a CAI course, by first programming lesson one, then lesson two, then lesson three, and so on without first bringing these materials before your students, getting their reactions, performance data, and some kind of base line information about the current level of capability, before you begin the actual detailed programming. A gr .t deal of time is wasted in preparing instructional sequences with extensive remedial loops which are eventually of no value to a significant number of students.

An important decision was to make the CAI physics course a multi-media course. We made an early decision not to depend solely on the computer as a presentation device but to take advantage of the excellent films which have been developed by the

Physical Science Study Committee. In addition, we took advantage of the film skills of a professor at Florida State who produced film loops of the experiments usually carried out by the instructor in front of the class. We also developed audio tapes which were, in essence, compressed versions of some of the lecture presentations. And we utilized, of course, a text book which the students were required to read prior to starting a lesson.

We used the CAI system itself for monitoring and guiding the students throughout the lessons, for continually reviewing their progress in both the testing and review mode, and for providing remedial information to the students. This approach to the development of the CAI course optimized the use of the resources which were available to us. Although there are no clear cut rules at this point which say that this should be presented via computer and this should not, it is our opinion that it is inefficient to try to do everything on the computer.

The third important aspect which evolved quite early in the project was that of staff differentiation. I think this is a critical concept in the development of CAI materials. We utilized several professors from the Physics Department at Florida State to provide the overall conceptual leadership in the development of the instructional materials. This was a role which they played very well; however, it would have been foolish and naive of us to expect them to spend a great deal of their time in actually writing and debugging all the instructional materials. These men are busy

with important research projects, and contrary to some of the early IBM thinking, there is no payoff at the present time for a professor to develop CAI materials. Therefore, we hired three physics writers, one with a master's degree and two with bachelor's degrees in physics who were competent and who were interested in the instructional process. They translated the general conceptual view of the physics professors into meaningful, instructional materials.

In this process, they interacted with the psychologists who were available in our Center and to people who were completely informed as to the capabilities of the computer system itself. These writers were the backbone of the actual development of the instructional material which was implemented on the computer as well as on other media. When the materials were completed they were h. led to the coders. These are people who are expert in the CAI language utilized by our computer; they did the first debugging of the materials and actually entered the information. We had computers operators, also, who ran the CAI system, computer programmers, who developed a data analysis system for us, and proctors whose role it was to work with the students as they came to the Center. These people, along with secretarial help, characterized the type of staffing which we utilized in the project. I cannot emphasize too heavily the necessity of having such role differentiation, and for maximizing the utilization of people's capabilities where they can contribute most significantly without dissipating their time and energies accross a wide range of tasks which would take much longer to master.

During 1968 and 1969, we conducted three field studies in order to evaluate the multi-media computer based physics course. Our students were sampled on a volunteer basis from the students regularly enrolling in the Physics 107 course at Florida State. The administration granted the CAI students the regular three credits for this course with the stipulation that the students take the regular exams which all the other students in the course would be taking.

In the first study we had 23 students who took their entire physics instruction by CAI. The outcome was a significant difference in the final grades of the students who took the course by CAI compared with a matched sample of students from the regular course. There was also a considerable time savings; however, we did not witness any great acceleration of the students' pace through the materials. In general, the students came to the center to take two or more lessons at one time and primarily scheduled their time in the Center when it was convenient in relation to their other course responsibilities.

The second study was conducted after the CAI materials were revised. We achieved in this study approximately equal performance between the CAI group of 37 students and a matched group of students in the regular course. Again, there was approximately a 15 percent saving in time.

For the third field study, we removed the films and most of the audio tapes from the course presentation so that the course was

only two thirds the length it had been in the past. The other third of the course time for CAI students was spent in class discussions of topics related to the physics course, and extension of these ideas in more advanced areas. The results of this study indicated that those students who completed all 29 CAI lessons performed equally well on the final exam as those students in the conventional course. The outcomes of these studies make a number of things quite clear to us; for example, the students see the major benefits of CAI in terms of its self-pacing aspects. There is also a great sense of working along with a tutor.

As a part of this physics project, we attempted to evaluate the cost/benefit of CAI. Immediately we encountered a problem in demonstrating the value in a monetary sense, of enhancing learning. In the University system budgets are generated in terms of credit hours produced and not grade points; and therefore, it is difficult to place a monetary value on an "A" as opposed to a "B" or to determine the value of achieving ten objectives as opposed to five.

However, in the final analysis, trends seem to indicate that the cost of CAI will continue to go down, and hopefully the effectiveness of CAI will increase within the next decade. It is apparent that the homework problems that were utilized by the initial students in Physics Project, prior to their various examinations, contributed approximately 10 percent gains in their learning outcomes on the exams. This appears to be a potent and very rewarding tool to students and we are considering the application of this particular aspect of CAI in other areas.

Generalizations.

In summary, we have discovered and evolved a number of generalizations about CAI curriculum development that you may wish to consider when other people talk to you about their views on this topic. The first of these generalizations deals with the systems approach. We evolved and developed our own version of the systems approach and we progressed through this project.

We did in fact analyze our tasks and our context. We did get to know the entry behavior of our students; we did formulate our behavioral objectives primarily on the basis of behaviors expected of the students on the tests. Instructional strategy was one of utilizing a variety of instructional media in order to try to optimize the capability which was represented by each medium. We evaluated as often and in as positive a fashion as we could.

You can learn the jargon of the systems approach in a relative short period of time; on the other hand, it is a very difficult and complex thing to seriously follow all the guidelines and procedures which such a model suggests. However, we feel that the curriculum development efforts of CAI are worth this effort and there is beginning to evolve some evidence that in fact this effort is worthwhile.

The second generalization is that the higher the criterion performance which you expect of the students for whom you are preparing materials, the more difficult will be your task of programming the course, and the more complex will be your

instructional strategy which you will have to employ, thereby complicating the development of your instructional materials.

Third, we are convinced that CAI is a tool which should fit within a curriculum and within an instructional setting; that is; it should not carry the entire instructional load but should be a part of a multi-media resource. One thing to keep in mind, however, is that the greater the variety of media which you choose to employ, the more complex will become the logistics for the student, and the more difficult will be the total implementation process.

Last, let me emphasize a point made earlier; you should be constantly aware of the role of staff differentiation, which seems to have high pay-off in terms of carrying forward a curriculum project. In other words, the burden should be spread among a number of people who have special aptitudes or training for the various tasks. Specialization within a CAI project undoubtedly increases your probability of success.

The Hardware

I would like to talk briefly about the other side of the coin in CAI, namely, the hardware or computer aspects of it. To educators, the computer itself is probably the least interesting and certainly the most costly aspect of computer-assisted instruction. In principle many of the computers available today from numerous manufacturers can be utilized for computer-assisted instruction. The primary reason why more different manufacturers' computers are not being used for CAI is the lack of CAI operating

systems. By this I mean that the software required to assemble the course material and to provide it in a time sharing mode with a number of student terminals is not available, and it is costly to develop.

The CAI computer system that is predominately found in the United States at the present time is the IBM/1500 system. The currently available versions of the 1500 system have a 1130 central processing unit which rents for less than $2,000 per month. However, the peripheral equipment required to complete the CAI system brings the total monthly cost anywhere from $8,000 to $12,000 depending upon the variety of audio-visual devices added. Clearly this cost is prohibitive in an operational setting. In nearly every CAI Center, the federal or state government is paying the bills in order to provide researchers with the opportunity to explore the potentials of CAI.

There are at least two solutions to this problem of CAI equipment cost. Perhaps your first inclination is to think of adding many terminals to the computer system in order to drive down the hourly cost per student. This concept has received some attention. The IBM Corporation is now making Coursewriter II available on its 360/40 computer system. As such it should be capable of driving more than 32 terminals; however the cost of the terminal devices is still prohibitive.

Several feasibility studies have been completed for the U. S. Office of Education on CAI systems which would serve 1000,000

students in a metropolitan area and would have approximately 1,000 terminals. The University of Illinois is currently attempting to develop a CAI computer system which would drive 4,000 terminals. I have no doubt that in time these systems will become operational; however, one of the primary costs involved in such large systems is no longer the central processing unit but the telephone line charges because most of these systems require one telephone line per terminal.

The second cost is the terminal device itself. Cathode ray tube (CRT) terminals are much like a TV set with a typewriter key board. These terminal devices sell for over $3,000. For computer systems with hundreds and thousands of terminals the cost would become extremely high. However, the University of Illinois is working on a low cost plasma screen terminal which may become operational in the near future. This terminal device should overcome some of the current technological problems and costs associated with the CRT.

The other development, in terms of the future of CAI hardware, is one that few people are espousing but at Florida State we feel that it has distinct possibilities that is providing CAI on a small computer which is a stand-alone, locally controlled, reasonable priced computer system. The results of our analysis indicated such systems could be made available for approximately $165,000 to $185,000 or at a rate of approximately $15.00 to $20.00 per student per year. This system would include the CAI operating system and

16 to 32 student terminals. The cost for this proposed system would be approximately 1/3 of the cost of the present 32 terminal CAI systems.

We also speculate in this regard that as time goes on two economic hypotheses will become reality. First, although the decrease in the cost of the computer central processing un will begin leveling off soon, we feel that the cost of the peripheral equipment and the terminal devices will continue to go down. Likewise, it seems a fact of life that inflation will continue to drive up the cost of instructors' salaries - that fixed item which represents anywhere from 70 to 80 percent of the educators' budget. These two trends argue for the enhanced economic feasibility of CAI.

With regard to computer systems, I would like to describe briefly one study which we have done at Florida State University which I think may have particular relevance to the field of adult education. This study began as a rather mundance comparison of student performance on a programmed text with performance by another group of students on a similar program presented by CAI. Although this is not a very startling idea there is remarkably little evidence of this type of comparison being carried out, at least it is not being reported in the literature.

This project evolved from a graduate student's efforts in which he developed a PI text which was utilized as source material for the development of an enhanced CAI course package. The package consisted of about 40 minutes of instruction on the topic of

significant numbers, a topic which is usually taught to eighth graders. The study was run once and the data were analyzed and replicated under better experimental conditions.

The primary finding of the study was that with high ability eighth grade students there was essentially no difference in their performance in terms of being on CAI or using PI: however, the performance on the final exam of the low ability students who used CAI was significantly less than that of the low ability students who utilized the PI text. As a matter of fact, on a retention test the low ability students using PI actually scored better than the high ability students using PI. The important point here is that the device that the low ability students were using in CAI treatment was a cathode ray tube terminal. The program did not provide the students with an opportunity to review in the sense that the student could review a PI text by flipping back pages. Information appeared on the screen, the student responded to it, and it was gone. The results seem to indicate that the low ability students may have greater need for memory aids or actual hard copy printouts. Perhaps this result might be generalized to include adults who might use cathode ray tube terminals.

On the final note on the utilization of a variety of instructional devices that are driven by a computer. One point of view would argue that in order to maximize learning you must have all the instructional devices under the control of the computer; that

is, we should have a random access audio device, cathode ray tube, light pen, key board, projector, and even TV and other display devices under computer control. It has been our feeling, based on some experience, that we prefer to utilize only the basic CRT key board, and light pen capability on the CAI system. This decision has been reached on the basis of, (1) the cost of additional devices, and (2) a genuine questioning of the trade-off or benefit which is to be derived from additional devices. We have found, for example, that students as young as junior high age are quite capable of utilizing a Kodax carrousel projector appropriately. We have also utilized flip pads which contain graphics, and work-books for additional writing activities. None of these devices was under computer control. We do not feel that the student has been handicapped in any way because of the situation.

In summary, the intellectual and economic battle will continue over the next several years as desirability of large computer networks for CAI is compared to small, stand-alone, full type purpose computers. The functional characteristics for the terminal will also become more important. If you are fortunate enough to have the funding available to actually implement CAI, there will be a number of pitfalls which should be avoided, or at least prepared for.

Let me briefly indicate the two primary areas of concern which I have identified. The first occurs in dealing with computer manufacturers. There are many problems which you can anticipate

in terms of delivery dates, total cost, one time charges, maintenance scheduling, and the like. I don't mean to imply that the manufacturers are out to deliberately deceive you; but often, if you are in a city in which they have never heard of CAI until you order your CAI system, it is very difficult to get people from within a manufacturer's sale organization who are familiar with CAI. Second is the problem of continuous on-the-job training of new people. We have found that after establishing a staff of computer programmers, authors, operators, coders, and psychologists, we have been able to increase their effectiveness by various on-the-job training techniques, for it is almost impossible to hire the services of trained CAI people. Florida State is one of the few institutions in the country where there are specially trained people with capabilities in the area of CAI and we are now producing our first significant number of doctoral candidates.

Computer-Managed Instruction (CMI)

As a final portion of my presentation, I would like to discuss some alternate applications of CAI and mention a sample of the research studies we have conducted at Florida State, pointing out what I consider possible implications in the area of adult education. Let us return to the classification scheme, namely drill and practice, tutorial, and problem solving. Although I spent some time discussing the tutorial mode, I would argue that the drill and practice mode will also have considerable application in areas of critically important learning skills in adult basic education. The very nature

of a CAI system makes it a very private learning situation in which the student can make numerous mistakes and the computer will continue to provide him with the type of material which he needs in order to master certain basic skills. The same situation repeated in the classroom would be embarrassing and humiliating.

Perhaps the most immediate demand for computers in education is what is now being called computer managed instruction or CMI. If you consider our physics project in which we used a variety of media, the computer played primarily a monitoring and an evaluative role. It is my understanding that this is what the majority of professionals would describe as computer-managed instruction. CMI is the overall management of learning materials and evaluation of students who are participating in a training program where the instruction is not primarily conducted by the computer but by the use of various types of instructional materials

Project plan of the American Institutes of Research is one example of CMI and Bob Glaser's work at the University of Pittsburgh with individually prescribed instruction, which now includes the implementation of a computerized monitoring system, is another. It is my observation that the type of instruction in which objectives are set for the student, and materials are provided to achieve those objectives, is becoming more evident. A student may select those objectives in a sequence which he feels is best for him, or the sequence may be prescribed by the computer. The student is totally, or partially, evaluated by the computer on his acquisition of those

objectives. It is a very significant step forward, not simply in the utilization of computers in education but in our philosophy of education per se.

In order to give you a concrete example of computer managed instruction, I would like to describe the graduate level course which is conducted via CMI at Florida State. The name of the course is Techniques of Programmed Instruction; its purpose is to have students produce between 30 to 60 minutes of programmed instructional materials which are developed in accordance with a systems approach model. Of course, under computer managed instruction, the content has been task analyzed and 20 primary tasks have been identified. For each task there are from one to three objectives. One half of the students are given a set sequence of objectives which they must follow; the other half are able to select any objective or task which they feel is appropriate.

After choosing an objective, the student is given a list of the resource materials which are available in order to achieve the objective. For each task there is basically, 1) a cognitive skill, such as proficiency in identifying the components of a behavioral objective, and 2) a product such as writing behavioral objectives. Ultimately, through reading the materials, meeting in small groups, and requesting presentations as they see fit, the students proceed to develop, evaluate, revise and again evaluate their instructional materials and document this whole procedure in a

final report. The primary role of the computer is to evaluate the students' performance on each of the cognitive tasks and to maintain a continuous record of where the students are in the course. Student requests for assistance can be raised with the graduate assistant, or the professor, We are analyzing both the role the professor plays and the ability of the computer to manage this relatively large graduate course.

As far as I know, this is the only application of Computer Managed Instruction in which students actually interact with the computer via a terminal which is operating in real time or in a CAI mode. In other applications of computer managed instruction, the student, when he has completed his instruction on an objective, takes a test which is then scored by the computer. The report is sent back either to the student or to the teacher who determines the next instructional sequence.

Other Applications.

The CMI course which we have implemented is a rather small beginning effort to try to understand the variables and complexities associated with computer-managed instruction. A larger effort which may be more prototypic of total adult education training programs is one that we are mounting in the area of elementary teacher training. Florida State has been awarded a U. S. Office of Education contract to develop the second phase of a model teacher training program for the preparation of elementary teachers. The Florida State conception of this training relies heavily on individualized instruction.

The present enrollment in this program at Florida State is approximately 800 to 900 students, with projections that can go as high as 1500 students. In order to implement an individualized program of this magnitude it is imperative that the computer be involved as a monitoring, scheduling, and evaluative device. The computer will continuously print reports for counseling by clinical professors in order that they may spend their time advising students in terms of the use of resources. The details of this model have not yet been worked out but it is a challenging task and one in which the computer will be an invaluable tool.

As you can see, by including these other examples of CAI, I am trying to broaden the concept of CAI to include more than just a tutorial mode of instruction. For example, we have run several studies in which it is quite clear that using a branching, testing strategy based on test item characteristics, one can very quickly and efficiently test students in a series of concepts without administering large batteries of questions. The final level of performance can be quickly identified. We have used the term sequential testing for describing the process in which a student is provided test items which approximate his level of performance on the preceding item on the test. The test is specifically adapted to his performance as he proceeds through it; therefore, this type of testing activity can be utilized in the same way conventional test are currently used. However, it is much shorter and quicker and has been shown to provide more reliable data.

Another interesting example of using CAI in a testing mode is currently under way at Florida State's Department of Social Welfare. Again, this may have some application to adult education. The students who typically enter the Graduate Department of Social Welfare come from a great variety of backgrounds. The initial graduate courses are often trivial to some and over the heads of others.

A battery of test items is being established in the area of psychology and sociology which will be made available by CAI to students entering the Social Welfare program. They will take these tests and be systematically evaluated at various concepts. For certain levels of misunderstanding, remedial activity will take place at the terminal. For students with very poor performance, additional materials will be made available and they will return and be tested later. It is anticipated that in this manner students can be screened and placed in either remedial activities or regular courses appropriate to their interests, skills, and program. They will no longer be required to participate in courses which are either beyond their capabilities at the present time or are relatively trivial on the basis of their background or undergraduate experiences.

Another successful utilization of CAI has been in the area of academic advising. A study of this application was made at the Tallahassee Junior College by one of our graduate students. He placed two terminals at the college and programmed a sequence of

information which was felt to be of value to the students. This information included the rules and regulations of the Junior College, information about grading standards, information on the basic studies program required, and courses that were available within that basic studies program. There was also information available on transferring to various colleges in the southeast, as well as specific information on Florida State University. The purpose of the activity was to provide the student with information which he needed to better understand the Junior College and its rules and regulations, and to give him official information about the program. The computer also provided the student with a listing of his current record at the college in terms of the courses he had taken, grades he had received, and his grade point average.

On the basis of his information about the junior college curriculum and his record there, the student at the end of his interaction with the terminal was requested to list the courses which he would like to take during the next academic quarter. The information was stored in the computer and evaluated by the counseling team at the college. Approximately 85 percent of those records generated by the students were judged to be good or excellent by a faculty jury. The system was heartily accepted by both students and faculty members. It is interesting to note that this is in a junior college where they take pride in the type of counseling they can provide the student. This application is cal of the use of computers to provide accurate information for a diverse population.

A Significant Question.

I would like to conclude this presentation by raising a question that is often debated by CAI personnel; that is, should CAI be used primarily as a tool in which we implement programmed instruction material or is it a totally different conceptionalization of the problems and capabilities which we can utilize? In other words, should we use CAI basically as a page-turner, or should we make it a very esoteric device? I think my answer at the present time would be to straddle the fence with one foot on either side. I would argue that if we are to prepare meaningful materials, get them running on a system, and begin producing results, the best way is to start with programmed instruction materials which have been developed with a reasonably good systematic approach, and utilize these materials to become more familiar with the computer, and to learn about our students' reactions to it. Unlike other media, the computer has an extensive memory system; it can make decisions and it can control media devices other than itself. It is because of these capabilities that many people have become enthusiastic about the long-range capabilities of CAI. Within the past year, we have begun exploring some of these capabilities, hopefully in a realistically simplistic systematic way to try to determine whether we can manage these capabilities.

EVALUATING PROGRAMMED INSTRUCTIONAL MATERIALS

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We have heard a lot about programmed instructional materials and how to develop them, but we have heard very little about evaluation; yet this is one of the most important aspects of instruction. Evaluation is an appraisal, and appraisal calls for judgment. Judgments are based on a critical consideration of the best evidence available, with evidence being the key word. We need evidence if we are to make judgments and evaluations.

Now, how is evidence collected? In man's search for truth he has traditionally used several approaches. Let's take a look at four or five of them in some detail. (1) One is tenacity. We hold to ideas we have always believed to be true; they are handed down from generation to generation, and sometimes we cling to these truths even when there is evidence to the contrary. We all know many examples, such as the early belief that the earth was flat. (2) Another is appeal to authority. We accept the ideas of subject matter experts, for example, because of their training and experience, but unless they keep abreast of new discoveries their advice may be conflicting. (3) Intuition is a third approach, but you know how often a hunch fails to pay off. (4) An additional approach is reason. There is the belief that we humans can arrive at truth by rational thought. Often,

however, such reasoning is quite false. A person can be very logical, but if the basic assumption that he starts with is incorrect, then his conclusions will be incorrect. (5) Finally, there is the scientific approach, using data that can be verified. There is testing involved, which is open to inspection, and you draw your conclusions from the findings. You don't just say something is true because you believe it is true; you say it's true because of evidence you offer. Objectivity is always a problem; it is very hard to be objective, especially when the data doesn't support your assumptions.

There are several of the methods man uses to search for truth or facts. Scientific thinking and scientific methods are a combination of various approaches. They may be labeled inside and outside. The inside methods are reason, formal logic, the deductive method, rationalism; this is the ivory tower. The "outside" methods are experience, observation inductive thinking, probability, critical analysis. These methods, deductive and inductive, are both used in the scientific method. The scientific method is characterized by, or is based on objective data. It uses hypotheses to test data; it is analytical and it strives for objectivity. It develops tools of measurement. We look for specific evidence and we use statistical techniques to compare findings. Measurements are developed and tested to assure validity and accuracy.

Evaluation Employees Scientific Thinking.

With this introduction then, we will discuss evaluation as a type of scientific thinking. The whole notion supporting research is the fact that you can define it in some understandable form and it can be verified. It promotes, self-improvement, and self-study for a person or an institution. The end purpose of evaluation is to improve what you are doing, to see if you have reached your objectives; and if you haven't, then to change things or try another approach. Evaluation involves three basic steps: (1) stating in precise terms the objective; (2) securing evidence relevant to the objective; then (3) drawing your conclusions or making a judgment. In other words, you collect evidence, you review evidence, and then you make a judgment in regard to the social utility of the process or activity.

Start With Objectives.

There are many approaches to evaluation. If you want to evaluate a method, or a program, you must know the goals and objectives of that method or program. Then you secure evidence to find out whether the objective has been accomplished, and you relate the evidence to the objective in various ways through statistical computations, and through rational judgment. We use all of our various means and their validity varies with the method we are using. The more control we have over a situation the more likelihood that our findings are valid.

Let's take a little closer look at analysis of objectives. First of all, objectives must be stated in terms that allow appropriate evidence to be collected. If I say one of my objectives is to teach you to understand Shakespeare, what do I mean by understand? How will I know that you understand Shakespeare? We define understanding in behavioral terms, and these must be observable behaviors. Sometimes it is hard to know what is going on in a person's mind and we only see secondary evidence of learning in terms of psycho-motor performance, cognitive behavior, or affective behavior.

Ways to Collect Evidence.

How do we secure such evidence? They involve both subjective data, such as opinions and attitudes, and objective data such as test scores; but all data collected must be clearly related to the objectives. Observation is perfectly legitimate. It is one of our oldest and best methods. Questionnaires, interviews; and analysis of cumulative records; all of these are legitimate methods for evaluating. The basic question is: to what extent do the available data indicate that the desired objectives have been, or are being, effectively accomplished? This is really what we are trying to find out when we evaluate programmed instruction materials, whether we have effectively accomplished what we are trying to do, the key word being "effectively".

Criteria By Which To Evaluate Materials.

Now how do we know whether we are effectively accomplishing this objective? We need some criteria. Everybody has criteria; for instance, you have your criteria for a good meal, and I have mine. You have your criteria for an educational program, and I have mine. One reason we need criteria is that thousands, even millions, of dollars are being spent every day on educational systems, hardware, and software. There is no end to the variety, and the manufacturers are turning out materials and equipment by the tons. Adult educators are buying these products, some of which are effective, and some are not worth the paper it's printed on. We need to study and find out which systems, and materials will accomplish specific learning objectives with persons having specified learner characteristics when used in a particular instructional environment.

Educators have been told that PI materials are created by testing and revision, and you expect evidence of performance. Evidence of performance is often poor, or is not supplied. There is a growing concern that PI materials are not being adequately field-tested. If you will review a program manual, you will see the kind of field testing done. For example, program producers will say that they tried the program out with 80 Uka Indians and put it on the market. Or they will say that it was tested in the Job Corps on 2000 people, but all of one type. How representative

are the materials? Will they work in your unique situation with your people in your geographic location?

Three professional organizations cooperatively drew up criteria for evaluating programmed materials, The NEA formed a joint committee involving representatives of the American Educational Research Association, the American Psychological Association, and the Department of Audio Visual Instruction. The committee published various reports.

They recommended criteria in two categories, internal characteristics and external features, or internal and external criteria. The internal characteristics or features can be revealed by visual inspection. From inspection some of the following basic characteristics can be assessed: (1) Detailed effective tasks to be accomplished with the content organized in such a way that you can see what the objectives are. (2) Level, forms and style. (3) The types of programming. (4) The length of the frames that are in the PI book. In addition, in editor's check list will note these essential items: (1) organization, how is the book organized and how the system is organized, (2) the difficulty, (3) accompanying checks, (4) accessory materials -- their convenience, ease in use, (5) the physical features, and (6) the cost.

External criteria are features that are not observable merely by inspection. These call for a little more detail and study: (1) What was the source of the program content; (2) what were the qualifications of the author; (3) what about the history of the

program, how was it developed; (4) is there an explanation of the tryout and revision that it went through, if any; and was it field tested; (5) are there any test data, are there data about the characteristics of the students used for validation? Was this population similar to the people that you want to use the programs with? If not, it is probably not appropriate.

There are critical reviews, you can read your professional journals, you can read your audio-visual magazines, there are various ways to gain knowledge of the program. Research is being completed and reported in education and related disciplines. Read these reviews and reports before you buy a program.

Evaluation of Results.

Most important to evaluate are the products of the instruction. These can be measured through achievement, retention, or transfer. Information is needed about instructional effects. How much did the student achieve? Was there any retention after he closed the book , or is that the end of it? Will this undereducated person be able to go out and make any application of learning? Can he make the change in his life style, in his self-concept as a result of what he has learned? These are important questions to which you should address your attention. Very few program materials on the market answer these questions, so you may have to conduct your own evaluation studies.

Here are three basic considerations evaluating programs: (1) Evaluate each program according to its merit in producing

the specific outcomes that you want, your objectives. If you don't know what you want the program to do, how are you going to buy a program to accomplish this? You must have objectives for your program, and then you seek the materials that appear likely to achieve them, or you can collect evidence to support your assumption that it will accomplish your purpose.

In other words, you ask of a given program, is it appropriate for your purpose? Is it practical, and do you have evidence of the effect that this program will produce? The Guide To Evaluating Self-Instructional Programs tells you how to set up a small study to do your own evaluation. After screening some of these hundreds of programs that are on the market, you may narrow selection down to two or three. Then if you are not sure which to choose, you can run a small pilot study.

(2) There are criteria for validating your own materials; some recommended by the same three professional organizations I mentioned earlier. The evidence should be based on a carefully conducted study which shows what the programs accomplish. People should report these validation studies in educational journals or in project evaluation reports. If the adult education centers will share these, and if the Adult Education Clearing-house in Syracuse will report studies in formats according to these criteria, it would eliminate a lot of our problems because just about everything on the market is already being used by somebody in the field. It is a matter of finding out whether a program is effective. Most

people haven't bothered to evaluate what they are using. They are just using the materials because of convenience or other subjective reasons few are happy and many are dissatisfied. Most users really don't know what their programs are accomplishing. Results should be carefully documented. If you are the director of a program and you say your program works, you ought to be able to substantiate this in some objective manner, not rely only on your own opinion. An opinion stated by an expert is fine; but all claims to effectiveness should be supported by specific evidence.

(3) The last thing we need to look at, a very practical matter, is cost. This may be the most important criterion. All the others are important; but sometimes this is the one on which you really make the final decision. You may find an ideal program but can't afford it. You figure what the program is going to cost you per unit, per student, the equipment cost. Some software doesn't require equipment and others do. What is your initial investment going to be, can you afford it, what is the long term investment, what is the training time per student and teacher needed in order to use the system? How long does it take the system to accomplish what you want to accomplish? What quality of student is required by this particular program; in other words, what student characteristics and instructional setting is this program designed for?

You need to know the answer to these additional questions. What kind of instructor will be required, or monitor, or proctor? Can a student aide administer it, or will it take a professional?

What are the logistics, space requirements? You only have so much space, where or how do you store the equipment? Then there are the power and maintenance requirements? What is the useful life of the hardware and software? Some programs are designed to run out quickly; what will it cost to modernize them? These are all important considerations in evaluating program instruction materials.

In conclusion, the responsibility for demanding quality instructional systems resides with the professional educator, who must become aware of, and be able to articulate program objectives and acceptable evidence of learning.

INTEGRATING PROGRAMMED INSTRUCTIONAL MATERIALS INTO ABE PROGRAMS:

THE LEARNING LABORATORY APPROACH

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In 1963 North Carolina educators and politicians recognized the urgent necessity for an educational program that would meet the need of every adult that was underemployed, unemployed and/or desirous of more educational training. In the same year the N. C. Department of Community Colleges was established. During the past six years, 39 technical institutes and 15 community colleges have been established and are now in operation. By establishing these institutions it was possible for the state to extend universal education and opportunities to every adult, regardless of his previous educational experience or training. The community colleges and technical institutes offer programs in college preparatory work, vocational and technical training, general adult education, basic adult education, and community services.

The Open Door Policy was adopted and has had its greatest impact on basic and general adult education programs. The Open Door Policy states that any adult will be accepted into the program and given instruction relative to his abilities, interests, and goals. We knew that any instructional program that we could develop would have to be individualized, so we started out in the fall of 1963 on an experimental basis to see whether we could pull

together materials that would take a student from where he might be to where he wanted to go on an individualized basis. About six months prior to the research stage, we developed and installed the first learning lab. To date, we have 94 comprehensive learning labs and more than 150 mini-labs. The comprehensive labs include subjects from grade levels one through fourteen, and many labs are especially designed to meet the needs of the adult basic student. Since the inception of the learning lab program here in 1964, it has expanded in other states, and probably 20 additional states are using a similar type of system at the present time. They developed into Job Corps programs, Youth Center and MIND projects, public school projects, Neighborhood Youth Corps, correctional centers, colleges and university projects.

In order for you to better understand what they are, let me try to define a learning lab and also the methodology employed. The learning lab can best be defined as an accumulation of commercially available programs and/or self instructional materials. These materials are arranged by subject in a logical sequence in relationship to grade level and general interest. The instructional technique is dependent upon the methodology which it follows.

As a teacher is a key person in a school or college, so the coordinator is the key person in the learning lab. The role of the traditional teacher must change when a new instructional technique is introduced. The coordinator serves as the facilitator in the learning process by bringing the student and subject together in a

one-to-one ratio and having the student interact on a one-to-one ratio with the subject to be learned. I think most of us will agree you really can't teach anybody anything, but you can facilitate the learning process by bringing the student and the subject to be learned together and letting them interact. The coordinator should be highly trained in programmed and self-instructional materials, capable of making educational decisions and of directing students through their assignments. The coordinator interviews, counsels, and seeks to establish and to develop an effective line of communication with the student.

Placement inventories are used to assess the student's entering behavior in reading, math, and English. The reading inventory is always given, but the English and math are given later if the student is reading below 5th grade level.

During the counseling process the coordinator indirectly encourages the student to state roughly his objective. Probably this is the first time that the student has stated in his own words what he would like to be able to do. The learning lab instructional program is developed on a sound instructional basis that is divided into four parts; (1) first is the stated objectives, or what we expect the student to be able to do at the end of instructions; (2) second is our assessment of the student, to determine his entering behavior, (3) next we provide instruction which is on-step, and meaningful to the student; and (4) last we evaluate his

progress. Any time you have an instructional program or system with these four components, you have the basis for a good system.

As I have mentioned, the coordinator is the key person. There is a very high correlation between the coordinator's ability and interest and the success of the learning laboratory program. If this person says the program is not going to work, you can be assured that it is not going to work because he or she will not allow it to work.

We have installed these learning labs in just about every corner and nook you can think of, purchased all materials at the state level, and took the material out to the lab as a gift to the institution. No matter how biased or prejudiced the president or administrative staff might be, or whether the project staff were stuck in a corner, the laboratories have done an excellent job regardless of such handicaps. The coordinator is the key person.

During the counseling process, the coordinator helps the student to state verbally his objectives or what he would like to be able to do at the end of instruction. Sometimes the student's desire is to learn to write his name. Not only do we help the student achieve this goal, but hopefully, higher and more complex tasks will be perceived and desired by the student. This, in many cases, is the beginning of an effective verbal contract between the student and the coordinator. The establishment and maintenance of an effective line of communication and verbal contract

serves as a guarantee that the student will remain with us for a longer period of time than he might otherwise do. This contract leads to greater motivation.

Each student is given a diagnostic inventory in reading and math. These adult students have failed test after test, but they have never failed an inventory; so when you tell them you would like for them to take the placement inventory they relax. But, if you say "test", they freeze up. This is just to determine their level of frustration. From these assessments an individual curriculum is tailored to meet the needs of each student.

This curriculum is developed for the student in relationship to his reading ability and stated objectives. Having evaluated a student by means of counseling and testing, the coordinator lists the programs that will take the student from where he is to where he wants to go. Here the student will quite often take part in selecting the material or program which he likes best, so you get the student involved in making decisions at an early date. If the student objects to a prescribed course, and since the student is always right, we let him start in a course of his choosing. He knows the door is open for him to come back and to start over in a more realistic subject and at a level wherein he can achieve success.

The student is thoroughly introduced to programmed instruction. This is most important because all of us have developed a pattern of behavior and we function in this pattern of behavior. The adult student functioning at a very low level perceives of a learning

situation as being in a classroom with one teacher and approximately thirty students. You have to re-structure his perception as to the learning process or as to his role in the learning process. If you fail to do this, the student will not adjust properly. So again the coordinator is the key.

We know there are several ways to learn, such as by listening or reading, but the coordinator's main purpose here is to re-orient the student to individualized instruction. A working relationship is established between the coordinator and the student, whereby the student knows the program will teach him on a one-to-one ratio, but at the same time he is confident in the fact the coordinator is there to help him over any hurdle that he may confront from time to time.

Students are placed at a level wherein they achieve immediate success. They are challenged by the more difficult material but are not bored by remedial skills. They are motivated as a result of their success in the more difficult material. This is what I refer to as on-step instruction. The whole process of the learning lab is that you never ask a student to do something that he is not capable of doing. Initially, we want to place the student just prior to on-step so that he can achieve success, and then move up to his on-step level.

This on-step can be defined as the maximum level of arousal in the learning process which can best be provided in the learning lab on an individual basis. The student sets his own best pace that

will allow at least an 85% rate of comprehension. Once the adult student has been introduced to the program and understands what he is supposed to do, he moves at his own rate. There is no outside competition, and the frustration in most cases has been eliminated. If students are placed too low, they are allowed to skip concepts or sections until they are challenged. This is to say, they are kept on-step to maintain maximum motivation in learning.

Since there are no formal classes, a realistic schedule is established for each student. This is important because most adult students will do what is expected of them if they understand and are properly directed. The schedule is developed relevant to his family and work responsibilities. The student takes part and helps the coordinator decide on a definite time and number of hours per week. After a realistic schedule has been developed and established, the student is told that he will be expected to attend at a specified time. The schedule includes a minimum of two hours of instruction per subject per week. If the students come less than four hours per week, they will not achieve the sense of accomplishment to the point that they will sustain the initial motivation.

In addition to the established schedule, the students are encouraged to work in the lab at any time, and as many times a week as they desire. This type of scheduling does not interfere with job and home responsibilities. Really, a lot of frustration adhering to a strict schedule has been eliminated once you make this type of program available to the students. Quite often, the

coordinator will tell the student, "If you can't come, call me" and when they do call that's great, because you know you have a good relationship with them.

Chapter, unit, and post test are administered to be sure the students obtain 85% or higher on comprehension. If maximum progress is not being made, program changes are made. Each lab contains the standardized test kit which includes the following: algebra, geometry, general math, trigonometry, reading, English, comprehension, and general science, government, history.

The physical facilities that exist in various learning labs vary; however, the basic requirements will include such items as a coordinator's desk, tables, chairs, a student cabinet assigned to each individual, file cabinets, and approximately 220 linear feet of shelving. Hopefully, there will be a room large enough to adequately accommodate about 30 students. The coordinator's desk should be located at some spot where he or she can control the traffic. Since the majority of students are enrolled in reading, the materials are displayed on a large table near the center of the room where students can get to them without creating a traffic problem. We have found that tablet arm chairs are not desirable at all because there is too much material for the student to manipulate and do adequate work.

We have found that anytime you use a device without audio equipment, after the novelty wears off it is nothing more than manipulating the software. If you are using audio equipment, you

should use the audio and visual together. We use such items of equipment as the Language Master, tape recorder (reel and cassette), and filmstrip viewers. At one time, we used the single Super-8 Concept projector, but found the films for this projector too expensive and not very interesting to the adult students. Presently, we are developing more of a multi-media system than we had before. My opinion is that the cassette recorder will really be a great innovation in the field of education. We have found that the adult students really like using the cassettes, or tapes.

Objectives of learning laboratories pertain to programs at any level of comprehension. The labs are basically designed to help adults achieve the following goals: (1) to give basic instruction and literacy training from grades one through eight, and (2) to prepare students who request it for the General Educational Development test. About four years ago, we tested the validity of the GED curriculum that had been developed. At that time, we had 600 students that came into one particular lab with an average reading level of eighth grade. In a period varying from twelve to eighteen months, each student completed his curriculum and had taken the GED test. Out of the 600 students, 588 passed the test the first time. I dare say that you could not get the same results with such a heterogeneous group with the same number of hours with any traditional classroom approach.

During the spring quarter of 1969, there were 5,692 students actually enrolled in the 74 comprehensive labs with 3,015 or nearly

53 percent below eighth grade. The average entrance level was seventh grade. Fifty percent, or 2,870, were male; 2,240, or 39 percent are non-white; 3,327, or 58 percent were enrolled for high school preparation; 1,231, or 21 percent were in academic programs; 840, or 14 percent in occupational trades; and 294, or 5 percent in general interest courses. The total cost of comprehensive labs will vary anywhere from $4,000 to $15,000 depending on the number of students to be served and available funds. The learning laboratory system is flexible.

I would like to share with you some of the accomplishments of the learning lab thus far. It has raised non-readers to literacy level, and a few to high school graduation. This required initial and comprehensive instruction in reading, English, math, science, and social studies. It has provided the basic academic skills necessary for admittance into the curriculum and the mastery of vocational level training such as auto mechanics, brick masonry, and similar trades. It has provided academic skills and knowledge necessary for admittance into the mastery of technical and college level instruction.

A survey was conducted several months ago to find out how the adults were doing who had gone through our learning labs and received their high school diplomas or GED certificates and had enrolled in two-year college programs. We wanted to compare their performance with the average high school graduates. We found that 80 percent of these students were in the top 20 percent of their classes.

I would like to sum up for you some of the advantages of a learning lab. Every student in the learning lab achieves success as a result of the nature of programmed instruction and the methodology used. Furthermore, success contributed to higher motivation among the students. If the students come to you, even though they are motivated, they will not maintain the motivation if they are not successful.

I believe that success is the greatest factor in sustaining the motivation of the students. The instructional material used in the lab reduces student frustration, since each student sets his own pace based on his rate of comprehension. Personality conflicts are significantly reduced since the students interact with the program text and a coordinator is always present. The labs are designed to meet individual needs on a variety of bases; educational, social, and psychological.

Scheduling is flexible; for example, one fellow who had dropped out of high school in the ninth grade spent four years in the navy, and came back wanting a high school diploma. He came into the lab at 8 a.m. and stayed until 5 p.m. for five days per week. At the end of five months, he had completed his high school curriculum. After passing the GED test with a high score, he decided to go to college. The coordinator informed him that he needed to come back to the lab and spend additional time in reading, math, and science. He then spent six more months on these courses. He passed the SAT test with a score of 1200.

This year, he is a junior in Electrical Engineering at North Carolina State University.

The nature of the learning lab instructional material compels a student to progress in a logical manner with minimum deviation from the program as outlined. Lab students have a higher rate of comprehension of such materials than non-lab pupils. Students retain this information much longer than if they acquire it in a classroom situation. The mode of instruction in the lab is more valid and more comprehensive in addition to being subject to less bias. The program offered to the students in the lab has greater continuity than its traditional counterpart in the same program. You will see the continuity built in once you see the curriculum. The materials used in labs are designed for adults, regardless of the grade level for which they are designed. The cost per student contact hour is less in this instructional system compared to the cost in a traditional classroom.

In summary, if the student can't read the program, he is not placed in that particular one. If he needs math at the seventh grade level, and he is reading at the fourth grade level, you must have a program with seventh grade skills but written at the fourth grade level. You never ask a student to do something he is not capable of doing. If he is not successful in one program, we switch him to another program. Programs are selected that are relevant to the student's needs, likes, and dislikes. In curriculum development, the student takes part in selecting materials that will take him from where

he is to his objective. Scheduling is flexible and students may be phased into a program at any time and phased out when their objectives have been achieved. In the learning laboratory our motto is "Learning by the yard is hard, but learning by the inch is a cinch".

SYSTEMATIC USE OF PROGRAMMED INSTRUCTION IN BASIC EDUCATION

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Introduction

The process in which programmed instruction (PI) is currently used in the basic education program at Draper Correctional Center is the result of almost constant change. Revision of techniques, trials of new and different methods of approaches are continuing. From the beginning of PI to the present, Draper has been very much involved in its application to adult education and, at times, in the development of programmed material.

In 1962, Dr. John McKee began an educational program at Draper with small grants from the Ford Foundation, the Alabama Board of Corrections, and the Aaron Norman Fund. Later he received grants from the National Institute of Mental Health (NIMH) which allowed further research to be conducted and experience to be gained in using PI with institutionalized adults. More materials were being produced and techniques for using these materials were developing. Experiments were conducted to try to determine more effective ways of utilizing them. Out of this experimentation evolved the beginnings of the method we now use.

In 1964, the first of three Manpower Development and Training (MDT) Experimental and Demonstration (E&D) projects was funded at Draper. Basic, or remedial academic training (using PI), social-skills

training, and training in several trades were offered and rigidly scheduled. Trainees in this project were required to attend basic education classes two hours per day throughout the program regardless of their grade level.

During the three years which followed, we conducted additional E&D projects which provided further opportunities to develop and refine the procedures we now use. In our present project we are requiring of a trainee only that academic training which is necessary for success in the trade he has selected. He may elect to go beyond this minimum and work toward a certificate of high school equivalency or possibly to prepare for college. Many have successfully done this.

Trainee Characteristics

This bit of history brings us to the present and the current undertaking at Draper. We are now conducting our fourth project, which is funded under Section 251 of the Manpower Development and Training Act (MDTA).

The oft-described characteristics of the under-educated adult require no elaboration here. There are, however, two characteristics which must be noted because they are of paramount importance in planning and implementing training programs for this population. The first is their attitude toward education. Having experienced only failure in public schools, they, in a learning situation, are usually either apathetic and numbered, or are hostile, suspicious, aggressive, and resistive. They are apt to view any educational

activity as an insurmountable obstacle course. Prison inmates, the disadvantaged group with whom I have had most of my experience, may treat the educational program as a game of wits, with authority as the opponent. Though they will conform, it is usually only to secure earlier release or to avoid an undesirable work assignment.

The second characteristic is their diversity in levels of knowledge. One vocational class of 80 had grade placement scores ranging from third grade to second-year college. This uneven pattern is an individual as well as a group characteristic. Undereducated adults, similar to people on any level of education, do not usually have a total absence of knowledge, rather, they have knowledge gaps. If grade placement scores on subtests of standardized achievement tests are charted, there will be peaks and valleys.

Importance of Individualization

These characteristics, poor attitudes and knowledge gaps, emphasize the importance of providing an educational program to meet the needs of the individual. His training program must be related to his own goals, and the relationship must be clearly defined for him. (The first step may even be to help him to set realistic goals.) Thus, to attempt to teach him only what he needs to know - one must concentrate on the valleys. And the valleys, which are his general deficiencies, must be carefully plumbed. It's like walking a tightrope. If we err in one direction we can attempt to teach material which the trainee has already mastered. If, on the other hand, we lean too far in the other

direction, we may present material for which the trainee is not prepared. It is desirable, therefore, to determine as precisely as possible what each trainee needs to learn.

The disadvantaged trainee should not be frustrated, but he can be frustrated if he is asked to study material he already knows or material at a level for which he is not ready.

These characteristics also mean that a conventional classroom approach had best be avoided. The conventional classroom generally recalls a series of failures to a man who has a deep-seated need for success experiences. Further, the conventional classroom seldom takes into account his unique pattern of knowledge and ignorance. This is a wordy way of saying that, at all costs, the disadvantaged trainee must be provided with a program which is designed specifically for him.

The most effective tool we have found for use in our basic education program is PI. We have built our entire basic education program around this medium. Our efforts have been directed toward developing a systematic approach, utilizing this relatively new teaching technique. It has been successful in our program where other older approaches have failed. In our situation it is the only tool which offers the flexibility we need. Any trainee can use PI materials if he is able to read - at the third- or fourth-grade level.

Reasons for Using PI

Some of the reasons we have adopted this teaching technique are:

1. PI materials are adaptable to almost any physical situation.

Trainees may work in specially designed study areas furnished with computers, or they may secure a paper and pencil program and work at their bunks.

2. PI offers the only method we know which will allow up to 15 trainees in one learning area simultaneously, each studying a different subject at a different level of difficulty. This one feature makes it worthwhile for our program.

3. It enables us to show an average grade gain of 1.4 grade levels in 208 hours of instruction. This includes all levels of training. Some large companies quote fantastic grade gains in extremely short times with the use of their materials, such as 4.5 grade levels increase in 55 hours of instruction. But when we learned what this meant, we discovered that these figures represented gains by trainees who were at approximately third-grade level at the outset of training; and this is where the fastest rate of learning occurs. They did not include those who began at fifth-grade level or above, where the rate of learning is usually slower.

4. It assists us in preparing over 95 percent of our candidates for passing the General Educational Development Test. (These trainees are selected on the basis of overall test scores, approximately eighth-grade level, upon entry into a six-month vocational and basic education training program.)

5. PI allows complete freedom and flexibility in individualizing the learning process for each trainee. We can treat specific deficiencies with no waste of trainee time.

6. It provides some intrinsic motivational characteristics which are sorely needed by adults as well as children. One of the most outstanding of these is that the trainee is able to succeed - something which he probably has not had a great deal of success in doing previously.

Characteristics of PI

In addition to PI being extremely flexible, it offers advantages which are not found in the materials which have been traditionally used in the classroom. The following characteristics are advantages which distinguish PI from other materials:

1. PI's training objectives are behavioral, that is, the trainee will be able to do something specific after completing a program.
2. Material is presented to the trainee in a logical sequence in which concepts and/or behaviors are broken down into steps which are small enough to be easily learned.
3. The trainee is required to respond actively to each step, that is, he is asked to supply information or perform skills immediately after they are introduced. If his responses do not require him to perform precisely the kind of behavior we are trying to teach him, they require that he approximate the behavior. When the response cannot be elicited in a real-life situation, such a situation is simulated.

4. The trainee receives immediate feedback to each response-he knows at once that he is right or wrong. If he is wrong he is told why. In good PI he is almost always right. This characteristic explains the behavior-shaping power of PI. The knowledge that a response is right in reinforcing to the learner. When he encounters similar situations in the future, he will be apt to make the same response.

5. Most definitions of PI will state that it is self-pacing, that is, trainees will learn at their own rate. Programs designed for use on an individual basis have this characteristic, and it is an important one. Indeed, it is this characteristic which makes a system such as we describe work. There are, however, programs for use by small groups of trainees whose skills and knowledge in a particular area are at about the same level. We use one such program at Draper to improve reading skills.

PI, because of the characteristics just mentioned, is ideal for use in an individualized system, thus permitting the teacher to handle a variety of learning problems within a single class. For example, a trainee who needs to learn a specific basic skill, such as how to add whole numbers, might be given one program while the trainee who has completed all of his assigned work and is anxious to move on to the next step might be given a different program which could enrich his learning either in breadth or in depth. As you will note, PI materials can be used in a variety of other ways:

as a means of recalling previously learned subject matter, to supplement classroom study, or to enable the trainee who has missed classes for various reasons to do make-up work and so on.

The Learning System

We believe there are four basic, critical steps in the systematic use of PI materials to obtain the type of results in basic and remedial education mentioned earlier. In sequence, they are: (1) diagnosis, (2) prescription, (3) management, and (4) evaluation.

Diagnosis

Background data must be collected. This should include age, marital status, socioeconomic background, employment, last grade attended or completed in public school, length of time since attendance in school, personal problems, and so on.

A test must be selected which can be used as a diagnostic instrument. We have used the California Achievement Tests and Metropolitan Achievement Tests. All levels of the selected tests should be available, as should alternate forms of all levels for post testing or continuing evaluation of the trainee's progress. Other tests are available, some of which are designed for adults. The tests which are selected should render a grade placement score, not percentile and stanine scores; the latter are of little use in diagnosing deficiencies when the result of the diagnosis is to be a prescribed study program. The primary reason for this is that PI materials which have been properly tested should be described in terms of the grade level for which they are suited.

Besides rendering grade placement scores, other features are desirable. Ease of administration and scoring can conserve staff time. Tests for which an item analysis is available are preferable; item analysis is indispensable in making a refined diagnosis. The test should provide some measure of reading ability, stated in terms of grade placement. One final but important point for consideration in selecting a test is cost. The expense of operating a comprehensive testing program can be considerable and should be carefully considered in terms of the budget.

Once a battery of tests has been selected, a further determination must be made regarding the proper level of the test to be administered to each trainee. We have used the GRAY ORAL READING TEST as a rough indicator in selecting the most appropriate level of the standardized achievement test to be administered. If this is not possible, the first section of the standardized achievement test can be administered and the trainee observed. If it is obviously too difficult or too easy for him, he should be given another level of the test. We understand that some tests will soon be available which will have built into them some means of selecting the proper level for individual trainees.

An item analysis of test results gives the manager (we refer to the teacher or instructor as a "manager") the first general indication of a trainee's weaknesses and strengths - the peaks and valleys mentioned earlier. It would seem that from an item analysis, one should be able to prescribe PI which would treat the deficiency,

but this is not the case if we are to be specific in prescribing remediation. For example, the SAT scores might show a deficiency in computational skills - this tells us nothing. When the item analysis is applied, it might reveal a weakness in division of fractions. This is a bit more helpful, but still not enough. The trainee might know everything about dividing fractions except that he must invert before multiplying. Determining this requires a more refined diagnosis. A pre- or post-test for a specific math course which covers fractions could be used to pinpoint the gap in his knowledge of fractions.

The result of this painstaking procedure is that the trainee can be assigned a portion of a unit within a course which will correct the deficiency, rather than an entire math course. This results in saving time and effort for the trainee along with other positive factors, such as allowing him to progress at his own rate and not tying him to a group which might move too fast or too slow. Since the entire procedure is individualized, the possibility that a trainee may be criticized by his peers for lack of skill or knowledge is reduced.

Prescription

After analyzing the available data and weighing it in terms of the trainee's goals, we prepare a prescription schedule for each trainee. The schedule is a record of the courses to be assigned and the order in which the trainee will take them. To prepare it, the instructor must consider the information he has gained during the

diagnostic process. This information will include achievement test results with overall and subtest scores and a measure of the level at which the trainee reads, the item analysis, any further diagnostic test results, and any information gained during interviews, including the trainee's goals and identifiable attitudes.

The instructor, after having selected and ordered PI materials for his trainees, will be familiar with the materials in terms of behavioral objectives, grade level, reading level, appropriateness for age level, and format or method of presentation.

Keeping in mind the age and approximate grade level of the trainee plus the information and insight he has gained into the trainee's abilities and interests, he weighs course objectives against deficiencies and selects the course (or courses - or possibly only a portion of a course) which the trainee will begin to study. At this point, the prescription is still tentative. It may have to be revised at intervals.

Management of the Learning Activities

Before the trainee actually begins his studies, he should have a counseling interview with the manager. During the interview, the instructor will review and interpret the trainee's test scores and show him how they were used to prescribe the programmed material he will use. The explanation should be couched in terms of the trainee's goals. At this time the trainee's commitment to his prescribed course of study should be secured. The means of properly using programmed materials must be explained, as should testing

and grading procedures. Any questions the trainee may have should be dealt with.

When the trainee begins to work with these new materials, he must be observed closely for the first few days. Any errors in prescribing should be corrected as soon as possible. Supervision must be maintained. Verbal feedback from the trainee, progress checks, and observations by the manager are all valuable tools which can be used in involving the trainee in his own learning process.

All of the aforementioned procedures require that the manager be thoroughly familiar with the program's content, grade level, and method of presentation, as well as with the performance, work habits, and specific deficiencies of the trainee if he is to successfully manage a program of this kind. He must also be aware that trainee performance can vary substantially because of factors such as the mode of presentation of the materials (a paper and pencil program as opposed on one which requires a machine), a trainee's interest in the subject matter, and the relationship of the subject matter to the trainee's academic or vocational goals. In addition, the manager must frequently search for reinforcers which can maintain desirable learning behaviors.

It has been demonstrated that productivity can be increased by utilizing contingency management procedures in the educational program. For example, a point value may be assigned to each programmed course on the basis of its length and difficulty, and,

on the basis of available money, a monetary value of the points may be established. Using these procedures, a student can earn money based on his own productivity. He is not, however, paid for merely completing frames. He has to pass unit and/or final tests in a course in order to earn points.

Such a plan need not be rigid in delivering reinforcement. Students may be paid once a week or they may be paid whenever they have accumulated a certain number of points; or payment for points earned in one course may be made contingent upon earning points in another course. A point system is an extremely flexible device which allows the manager to schedule reinforcement and vary the value of points and the contingencies of earning them as he sees the need. The learner should receive reinforcement only after he has performed specified tasks which meet the established criteria in the educational system.

Other motivating techniques, such as progress charts or graphs, may be used. The trainee's own academic goals, when discussed with him, are often highly motivating. Other goals which depend upon more adequate basic education, such as higher level vocational skills, may be used to motivate trainees. Many of our trainees are not aware of the most basic requirements for advancement. Life goals, if they exist, are frequently established in childhood through the influence of social contacts. The disadvantaged are not usually exposed to the influences which cause individuals to give thought to predominant life motives. But these motives can be developed in

educational training, particularly if progress in basic education can be related to personal advancement.

Evaluation

Any learning system must have provisions for evaluation. The most practical means of evaluating student or program progress is to administer a test. To measure a student's accomplishments in the basic education program, we administer a different form of the same standardized achievement test which was initially given. If Form AM of the Metropolitan Achievement Test (advanced) was administered when the trainee was admitted to the program, Form BM of the same test is administered when he leaves. By comparison of pre- and post-test results, we can evaluate the trainee's progress (which we feel is also an excellent evaluation of our procedures). Comparison of pre- and post-test item analysis should give an extremely accurate analysis of procedures.

In order to evaluate any procedure, detailed records must be kept. All test results, including standardized achievement tests and tests on assigned courses, are recorded along with all pertinent dates, manager's comments, and so on. By carefully recording all pertinent data, we are able to maintain an ongoing evaluation of our diagnostic and prescription processes.

Other factors involved in evaluation of a program are frequently based on observation or discussion with trainees. A close look at the morale of trainees and staff, interest in learning (or the lack of it), and problems created by unacceptable behavior in the learning

area can provide supervisors with information which is invaluable in operating a program.

In short, evaluation depends upon accurate and detailed record keeping (records which should be used -- not just accumulated), on-going observation of the trainee and the learning environment. Evaluation should be a constant procedure -- not something which is done when the course or project is completed.

Recommendations

From our experiences we can now list a number of suggestions for training disadvantaged populations similar to the one at Draper Correctional Center. However, these recommendations are merely guides to behavioral engineering and we still require some imaginative adaptations when employed in other settings.

1. Use frequent and consistent reinforcements when the desired behavior is obtained, whether money, congratulations, or a pat on the back -- anything to reinforce the desired behavior.
2. Keep steps in learning small -- to avoid any semblance of anticipated failure.
3. Give frequent and positive feedback regarding performance.
4. Carefully justify to the trainee the subject matter to be learned in a practical way - make his learning relevant to his future.
5. Treat the disadvantaged as trainees, not students. The latter suggests to them that they are not adults.

6. Give tangible evidences of achievement, such as certificates of award, progress charts, posting high test scores - remembering that it's the educational system that is at fault when the learner fails.
7. Provide a consistently positive atmosphere for the trainee.
8. Do more than pay lip service to the concept of individualized instruction: practice it by using the latest developments in educational technology.

Perhaps the disadvantaged are not much different from the rest of us when it comes to training conditions and procedures. But two marked differences do stand out: their deficiencies and strengths are unevenly cast, requiring an individualized remedial program. Also, the disadvantaged generally have been deprived of that reinforcer we call success. We should give it to them often.

Sources for PI

Just finding out what is available in PI material is a major task. For this purpose, two resources appear to be indispensable: "The Automated Education Handbook" and the "Hendershot Catalog". Both references list programs by subject matter. Each also contains information about grade level, price, and publisher. "The Automated Education Handbook" gives a better description of the materials available. In addition, it contains essays and discussions on the theory and use of programmed instruction. The handbook is, however, an expensive volume; the catalog may suffice strictly for ordering purposes. To acquire programs to evaluate one peruses these volumes

and orders examination copies of programs which appear to cover the desired subject matter at the appropriate level and for a price which is within available means.

No programmed instructional materials of system of instruction is intrinsically valuable. It must be considered in the context of target population, adaptability to curriculum,time, motivational characteristics, measurable outcome, and budget.

DEVELOPING PROGRAMMED INSTRUCTION (P.I.) SYSTEMS AND MATERIALS

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Whether a program meets the needs that you have can only be determined if you try it out and see for yourself. You have to try out programs ("TOP") in your own setting.

Don't believe the propaganda that is attached to programs unless it is indicated that they were tried out on your type population. Programmed instruction should be "guaranteed learning" and if it is not, then you do not want it. But when it is guaranteed to do one thing, and you want it to do something else, don't be surprised when it does not work for you.

Probably no technique has been more incorrectly used than programmed instruction because I say "it works fine", you try it and it doesn't work for you. But you are trying it out on one group of people and I have evaluated it on another group of people. Any type of teaching can work, and work fairly well, in a situation where it meets the need. Most methods can not be used to meet different needs. They often fail with some group.

People keep saying that programmed instruction is going to save a lot of time, a lot of effort. This is not so. If you have an efficient method of teaching, you will find that in programming it you will (1) not hurt the student, (2) not save any time, (3) not save any money. But if you have an ineffective

way of teaching you will find that this is probably the greatest way of moving from the 18th century to the 20th century that has been developed and it will move you there in one step. The reason: what you do in PI is unique; you listen to the learner!

Programmed instruction is an efficient and effective way of getting from the subject matter experts what they consider the learner needs to know. Most teachers are really not good at defining what the learner needs to learn. In my opinion, teachers have only two jobs. One is to define what should be learned and the other to see if it is learned. Only subject matter experts can define the parameters of what needs to be learned as they know what "isn't to be learned". They have to have more knowledge than they are trying to communicate before being a good teacher. A teacher has to know more than he is going to teach so he can determine what should be taught and what left out.

A teacher has to see that learning takes place. That is to evaluate. Many times you will find that if the parameters of what is to be learned are determined, you have only to write a complete final examination. Then anybody to whom you would give an "A" would know everything they need to know about the subject. Once you know what the objectives are, teaching is easy, or, at least, easier.

In writing programmed material our biggest job in the medical profession is getting the professors to determine the boundaries. This is hard work!

People will tell you that to properly analyze your job (look at what you want taught) requires at least 50 percent of your effort. In other words, if you are going to teach a college course, you should spend as much time in writing your final examination as you spend during the entire quarter teaching that material! See why this is revolutionary?

In an industry, the person who controls the money controls the business. In learning, the person who controls the evaluation controls the learning. If you tell students "these questions are going to be on your final examination" you can be sure what they are going to study. You have determined their learning.

If there is a logical sequence in what is to be taught, the teacher has the responsibility of finding and teaching it. That is the reason the subject matter experts must analyze their material and find out what part of it must be learned. What programmed instruction writers have done, and good teachers have always done, is to get at the schema. That is, get at the underlying relationships of the material to be learned. And this is what a systems analyst tries to do; he tries to force the expert to look at his material a second time. What is it you really want taught? Programmed instruction is unique in getting at the "objective" (what you want taught) and devising a schema. This is what has been added to the old teacher-learner process.

Everybody writes programs a little differently. And when anybody tries to teach you the way he does it, listen to him

and thank him because it is interesting, and then ignore it. You no more want to copy somebody's method of writing programs than you want to copy Hemmingway's style if you are going to write a novel. You should write your own way when you write material just as you teach your own way. Your personal touch in teaching needs to come through. There are many things that you have to do to find out for yourself just what you want taught. I don't care what method or technique you use--usually the subject matter; the learners or your personal style will determine this.

This week you have a tremendous group of people here. Everyone of them has come up with his solution to the problem, and each is going to show you his solutions to the problem. The first thing you do when you leave here is forget what they said as far as their solutions are concerned. The way they arrived at these solutions is what you should be interested in. How did they go about doing it? What underlay the preparation of material? What are learning processes?

Do not believe anybody when he tells you this is according to "learning theory". If we had a single learning theory that was adequate, teaching would be simple. But there are many learning theories and if you want to set up a model for a doctorate in experimental psychology in the field of learning, you have to set up a minimum of five models to see which your controlled learning fits. We are babes in the woods as far as knowing about learning so I suggest you be an eclectic pragmatist: anything that works is acceptable! You try it out and see if it works.

You must try out methods as well as techniques and definitely try out materials.

Most of you are not going to be developing materials; most of you are going to be using them. You need to know whether they will work with your population, with your people. Try them out and see. It doesn't matter whether it is a video tape of a slide or a piece of paper, or whether it's a learning situation where they are working with three dimensional tools. Whatever works is what you want to use.

To be sure you do it efficiently and effectively you must analyze your needs first. Spend half of your time determining what it is students need to know for this job. What are important things that you want done on this job.

What is the underlying schema or what are the aspects that tie the whole thing together. We found that professors at the Medical College of Georgia are not interested in students' just learning facts. They want them to know how to use this information. How do you find out if a person can use facts?

In most professions and in most trades there is evaluation to see if a person can do a job. How do you evaluate? In medicine the student is expected to solve a problem or to be able to work with a patient. But what really happens in a medical school? A student works up information on the patient; a resident physician is also getting information on this patient; case history, physical examination, lab studies, etc. The medical student is expected to

decide what the problem really is and come up with the diagnosis, and what to do about it. But the student knows good and well he is not going to be allowed to kill patients, so he considers much of this as merely an exercise. No matter what he does it won't make any difference. How can you put the student in a place where he can make errors and see the results of his errors? What would actually have happened to the patient if he did not get an adequate history? What would have happened to the patient if he made a wrong diagnosis or treated him in an inadequate fashion? How can you put him in a real situation to show him what is happening? You can't turn him loose on patients. But the student must be in a position to actually see that his error is going to kill a patient.

We prepared programmed problem solving cases and the student goes through these branching programs and is allowed to make errors and continue on through the branches. When he gets to the end it may say something like: "Unfortunately the kidney you took out of this patient was the only kidney left; you did not do an adequate history an.. .ysical examination; go back and re-work this case."

Another time when the student has gone through certain choices he may see, "The patient lived, but unfortunately you butchered her. Her husband is seeing another physician and if he finds out how unnecessary the operation was you may be slapped with a mal-practice suit."

These cases are real to the student. I have watched medical students who have complete control of gathering data and material on

a patient (working to the best of their knowledge and with the best of intentions) find they have harmed and not helped the patient! These students will turn as white as a sheet when they see the error, they start rubbing their hands, and even get up and walk out of the room. They are in a much more real situation on paper than they have gotten anywhere in medical school. They vividly see that good intentions and the level of knowledge they have are not adequate for them to take good care of patients.

Talking to a group of physicians in South Carolina last month, I asked them what was the primary reason for the recent errors they had made. And without exception, everyone of them said that he did not have time to get an adequate history on the patient. Each one said he should have found out something more about the patient and, if he had, he would have acted differently. Their problems were not lack-of-knowledge but lack-of-time and are not given to solution by PI!

How does one prepare problem cases? The material must be prepared by people who have actual clinical experience. The best care is one in which a competent person has made a mistake. The case is prepared so this mistake won't be made by others.

Programmed instruction is a general approach. "PI" has become a part of the language and it means many things to many people. It is like the elephant and the blind men, different ones of us have approached different parts of it.

In medical school the vocabulary is an important part in teaching factual information. As students go onto each different service for two or more weeks, they have to talk to the professors in the professors' special languages and, believe me, every specialty has its own language. How do you teach this quickly to a student who is coming on the service, so he hears correctly and asks good questions? Each professor states what he wants; then we give this information to a student who is paid to write a text. This text must teach so that he would be willing to accept the grade that his classmate would make on an examination by the professor. Strange as it may seem, they can do it once the area has been defined.

At what level should a third year medical student know a given subject? The amount and depth have to be determined by the professor, for they determine what the students don't need to know as well as what they need to know. The professor sets the boundaries and gives us a series of exam questions. We let the students write or re-write in consultation with the professor, these questions. Then the student learns the answers and teaches his classmates. We tell a student that he has two months to learn the material and write a program. It takes him one month to learn the material but after he has programmed it he must teach his buddy in a few hours.

Usually, we can get professors to write material, once. It's hard work, time consuming, and they are already working 70 hours a

week, so we have found that the best writers are our student learners. Students like it for they are learning while they are writing, and they are getting paid for it. Writing material is such hard work that most people will do one good program and quit.

Help in writing programs is available from books and workshops as well as from professionals in the National Society for Programmed Instruction. These are several with material on programmed instruction.

The Armed Forces have been working programmed instruction since World War II. Since then the military has been putting several million dollars a year into programmed instruction research and development.

In the United States Air Force Air Training Command alone, a list is prepared every few months for the Commanding General indicating every training school for officers and enlisted persons and stating how much of the course is in self teaching format with an explanation why the rest of it isn't. The military now trains its own programmers and its own analysts. Materials are now available in many technical fields that work beautifully in self-paced self-teaching.

I repeat that my advise to every person who is in the area of teaching, supervising, or managing learning programs is to "TOP" (Try Out Programs).

I think that you will find that programmed instructions, particularily programmed texts are good when you have determined the need, and they are prepared to meet the need thus giving you

efficient tools. But I must say that, in my opinion, you use programmed instruction and carefully programmed texts as a last resort. Any other way that can be used to teach is usually less painful and more enjoyable so if they learn as well, use other methods. If these do not work, you really have a NEED, remember "programmed instruction is like a girdle". It's uncomfortable, it's miserable, it's a straight jacket; but at times nothing else will take its place'

MULTIMEDIA PROGRAMMING

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The world of instructional media can be a world of confusion because there are so many different types from which to choose. It has been said that we use media simply because they are there, and unfortunately this is sometimes true. One solution is to employ a variety--the more the better--without regard to appropriateness or need Another is to back off from the multimedia approach to instructional design, relying heavily on the familiar spoken or written word rather than daring to venture into the wide world of media. But these are non-solutions; each, in its own way, sidesteps the issue. There is no simple solution, but it is possible to find satisfactory answers to the question: What should I use to teach <u>this</u> topic to <u>these</u> students under <u>these</u> conditions?

To start, let us consider some of the possibilities involving visuals. Not everything can be visualized, but for the most part there are few presentations that could not be made more effective by the inclusion of some form of visuals. The only purpose may be to make a dull topic more interesting, but this reason enough. Carefully selected visuals will usually cause the student to attend more closely to the verbal content of what would otherwise be a routine and relatively ineffective presentation. Thus, it is

an appropriate use of the visual medium and one that we tend to overlook.

There is, of course, much more to visualization than interest value. All too often we instruct verbally when it would be far better to use visuals as the primary source of instruction. For example, when we talk or write about a concrete object, we form a mental picture of it and then describe what _we_ see in that picture. The trouble is that there is no guarantee that _our_ mental picture will be transferred without change to the student. The mental picture he forms will probably be incomplete, inaccurate, or both. The more complex the object, the more the problem is compounded. For instance, how would you describe a spiral staircase to a student who had never seen one? At best it would be difficult, more likely it would be impossible, and most certainly it would be a waste of time to even attempt such a description. All that is needed is show him a picture and say, "This is a spiral staircase". And you could be sure that the next time he sees one there would be a better chance that he would recognize it than if you had used the proverbial thousand words. In both this and the previous example, there would be a wide choice as to the type of visual to use. Photograph, line drawing, black and white, color--any of these would do, provided it furnished an accurate representation.

In almost any type of vocational course, there is a considerable amount of discrimination training that precedes actual on-the-job practice. Visuals are extremely useful in teaching such discriminations.

Here, however, the selection of the particular type of visual becomes more critical, and the characteristics of the target population and the constraints of the instructional setting, as well as the nature of the subject, may enter into the decision. For example, one of our company's recent projects involved teaching nurse's aides to discriminate between correct and incorrect hospital procedures. Photographs could not be used, primarily because there was too much extraneous detail (wrinkles in clothing and bed linens, shadows, superfluous objects such as toilet articles, permanent wall fixtures, etc.). For instructional clarity, it was necessary to use original art, and developing the final art style required a long series of tryouts. Black and white line drawings were acceptable to the contracting organization--but not to the target population. For some reason that has still not been precisely determined, we had to use colored drawings, even though color itself was not a critical element of the basic discrimination. Line drawings, no matter how highly cued with labels, "failed" in developmental testing.

In some instances it was necessary to show progressive movements, for example, how to bend down, pick up an object on the floor, and then return to an upright position without suffering body strain. We found that three body positions--all the way down, halfway up, and standing upright--provided an approximation to actual movement that was close enough to preclude having to go to the intricacies of animation.

Verbal information was presented on audiotape in the form of a dialogue between an instructor and a student. This scriptwriting technique was largely determined by the characteristics of the target population. Even though the training was provided in an individual setting, the aides simply did not feel at ease when the instruction was aimed directly at them, which interfered with their learning. But when they watched somebody else being instructed, they no longer experienced any constrictive, personal involvement and entered wholeheartedly into the instructional situation. At the beginning of the sequence, the instructor would invite the viewer to participate by answering the questions he was going to ask of the student on the screen. Both the viewer and the student marked their answers on a response card, and then either the instructor or the student gave the confirmation. (As an additional self-confidence builder for the viewer, the student did not always get the correct answer!) Note that the hospital training program involved a combination of two media; audio and visual.

Another course developed by our company resulted in a mix of several media, each one dictated by the nature of the subject matter, the characteristics of the target population, or the conditions under which the instruction was to be provided. The project concerned the development of a self-instructional course to teach the soldering skills needed to qualify for employment as an electrical assembler. Job performance involved not only numerous discriminations, but also a variety of skills ranging from gross motor sequences to very

precise manipulations. Note that the instructional burden did not end when the trainee had acquired the preliminary discrimination training. In this case, there was no on-the-job practice. Thus, the course had the added responsibility of teaching the actual performance skills. In addition, it had to be in the form of a complete do-it-yourself kit. It had to include all the tools and supplies that the trainee would need. It had to include all of the instructional components, both software and hardware. And it had to include everything the course monitor would need to evaluate the trainee's performance. The monitor could not be expected to have any degree of expertise in this particular performance area; he would probably be as unskilled as the entering trainee.

The course was first designed in skeleton form in the terms of behavioral objectives, and was then expanded to include the descriptive information required to teach the various kinds of discriminations and procedural steps that the trainee had to complete successfully. This, of course, also involved determining the order in which the steps should be taught.

Two factors entered into the selection of audio for all verbal directions. First, the reading ability of the target population was very low, approximately fourth grade level. This factor, however, was less important than the second. We would have used audio regardless of the level of reading ability. This particular course involved performance from beginning to end. It was necessary

that the trainee be able to watch what he was doing at all times. "Reading" his way through the course would interfere with his visual attention to his performance, but with audio instructions this problem was eliminated The speed of the audio presentation had to be carefully timed. Everything the trainee did--picking up a tool, using it, putting it down and selecting another--had to be taken into consideration.

The second media input was visual, and numerous visuals were required throughout the course. The primary purpose was to give the trainee a standard against which to compare his own performance, in other words, to provide the means for making the necessary discriminations. The visuals were generally in the form of drawings so that the item could be enlarged and more emphasis could be placed on details. The illustrations were housed in a stand-up book directly in front of the trainee. He had merely to lift his eyes momentarily from his work, without moving his head, in order to make a visual comparison. There was no instructional advantage to be gained from projected visuals, nor was there any need for color. In fact, color reduced the effectiveness of the illustrations. (This was in direct opposition to the findings in the hos ital training programs, where color was equally unnecessary but had to be used to obtain effective visualization.)

There were some objectives that could not be achieved with still pictures because a time factor entered into the sequential performance of the requisite procedures. This involved another

visual input--motion picture. Note that we did *not* use color or projection because they were not needed, and we *did* use motion pictures because we could not do without them. In each case the selection of the appropriate medium was not made on the basis of an arbitrary decision. *We* did not select the visual media. Rather, they selected themselves in that they were determined by the performance requirements of the pertinent objectives.

It proved impossible to clarify all of the visual features of soldered connections with two-dimensional drawings, which meant that still another medium was required--the actual object. This provided the trainee with the necessary three-dimensional view, in addition to allowing him both to observe and to feel surface texture. Again, the selection of the appropriate medium was a function of the instructional need.

In summary, the design of multimedia programs should follow the same basic approach used in the design of any other type of presentation. Specific media should be selected, not because they are fun to use nor because they happen to be there. Media, like procedures and techniques, should be chosen primarily on the basis of the performance requirements of the objectives, then modified as necessary to conform to the needs or limitations of the target population and instructional setting.

ERRATA SHEET

To Accompany the Publication,

PROGRAMMED INSTRUCTION AND COMPUTER ASSISTED INSTRUCTION IN ADULT BASIC EDUCATION

Please make the following corrections on your copy:

P. 3 - "Norbest Wenier"--change to "Norbert Wiener"

P. 16 - "Norbest Weiner"--change to "Norbert Wiener"

P. 20, line 4 - "accomplished" instead of "accomlished"

P. 24, line 5 - change "images generated on paper and images"
to "images generated on paper are images"

P. 24, line 9 - after learner insert "more"

P. 69, line 16 - "per hour"--not "per hours"

P. 75, line 4 - insert "3." before "Like McKee's work"

P. 93, line 4 - insert "deviations" after "significant"

P. 95, line 22 - insert "who" between "people" and "wanted"

P. 96, line 15 - "are able to" rather than "are chute"

P. 105, line 20 - insert "it" before "is"

P. 107, line 1 - "hierarchy" instead of "hierarch"

P. 111, line 22 - "ancient Sumer" rather than "Summer"

P. 128, line 15 - "vague" instead of "vauge"

P. 131, line 2 - "product" instead of "produce"

P. 132, line 16 - "corollary" instead of "collary"

P. 144, line 2 - capital, for Educational Advancement Center

P. 144, line 6 - "a short test" instead of "short tests"

P. 150, line 9 and line 19 - "Suppes" not "Syppes"

P. 150, line 10 - colon after CAI instead of a semicolon

P. 157, line 22 - insert "the" before "Physics Project"

P. 158, line 14 - "relatively" instead of "relative"

P. 160, last line - "100,000" instead of "1000,000"

P. 161, line 20 - insert "--" after "possibilities"

P. 162, line 16 - change "mundance" to "mundane"

P. 163, line 22 - change "On the" to "One"

P. 166, line 16 - insert "The" before "Project plan"

P. 177, line 22 - change "Uka" to "Ute"

P. 179, line 24 - insert "in" after "considerations"

P. 180, line 10 - insert "(by Jacobs, P. I., Maier, M. H. and Stolurow, L. M.
Published by Holt, Rinehart and Winston)."

P. 203, line 5 - change "in" to "is"

P. 220, line 22 - delete hyphen from "malpractice"

25, line 6 - insert a period (.) after "need"

25, line 18 - insert "'s" after "this"